study of non-point agricultural pollution

prepared by:
penobscot county
soil & water
conservation
district

assisted by:
soil conservation
service
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agriculture

STUDY OF NON-POINT AGRICULTURAL POLLUTION

SNAP

PENOBSCOT

SOIL AND WATER CONSERVATION DISTRICT

Sponsored by:

Maine Soil and Water Conservation Commission
Department of Environmental Protection
State Planning Office

In Cooperation with:

U.S. Department of Agriculture, Soil Conservation Service
USDA 208 Committee

Under the authority of Cooperative River Basin Surveys and Investigations, (Public Law 566) which provides for cooperation among the U.S. Department of Agriculture and state governments and other federal agencies in studies of land and water resource problems.

This study was conducted in compliance with all requirements respecting nondiscrimination which provide that no person in the United States shall, on the ground of race, creed, color, sex, or national origin, be excluded from participation in, be denied benefits of, or be subjected to discrimination under any activity receiving federal financial assistance.

Introduction to

Study of Non-Point Agricultural Pollution

SNAP

This three part report discusses three sources of agricultural non-point pollution. Part I discusses the causes and effects of soil erosion and possible treatment. Accompanying maps show the location of cropland fields (10 acres in size or larger) and rates of soil erosion on each field. Part II discusses animal manure: the amount produced, disposal techniques, and water quality considerations. The numbers and locations of farm animals (in terms of animal units) are identified on these same maps. Part III discusses the use of agricultural chemicals and their impact on water quality.

The Study of Non-Point Agricultural Pollution was prepared to assist soil and water conservation interests in using limited resources to solve local problems.

The objective of SNAP is to identify the location, extent, and kinds of agricultural activities causing excessive soil erosion and water pollution from sediment, animal manure, and agricultural chemicals. It is not the intent of this report to single out any individual or farm as creating a pollution problem, but to identify problem areas and the resources needed to solve these problems.

The study was endorsed by the following agencies--all members of the statewide USDA 208 Committee--and conducted through the assistance of their personnel:

U.S. Department of Agriculture
- Agricultural Stabilization and Conservation Service
- Farmers Home Administration
- Forest Service
- Science and Education Administration-Extension
- Science and Education Administration-Federal Research
- Soil Conservation Service

Maine Forest Service

University of Maine

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SUMMARY

Soil erosion on 13,765 acres of cropland in Penobscot County Soil and Water Conservation District (S&WCD) averages about 4.4 tons per acre per year. On a town-by-town basis, annual soil loss ranges from 2.7 to 9.8 tons per acre on cropland in the 28-town area. Some fields lose in excess of 18 tons per acre per year. Steep and long slopes were determined to be major factors contributing to sheet and rill erosion. More than 7,500 acres of cropland need conservation measures applied in varying degrees of intensity.

Over 60,000 tons of soil are lost to sheet and rill erosion in the Conservation District each year. Some of this eroded soil, plus some of the associated nutrients and farm chemicals, reaches surface waters.

Extensive erosion can be reduced by the application of conservation practices, but these practices require commitments of money from the taxpayer; technical expertise from government agencies; and money, time, and management from farmers.

There are 150 dairy farmers in the Conservation District, 126 of which have more than 25 animal units. Average herd size is 72 animal units.

All livestock farmers should develop and follow animal manure recycling plans. An estimated 60 to 70 dairy farms need technical and financial help to solve manure storage problems. Nineteen of these are high priority. The estimated cost of carrying out these high priority manure management systems is between $300,000 and $375,000.

One poultry farm is mismanaging its manure resource.

As a result of animal units, 215,000 tons of animal manure must be recycled yearly in the S&WCD.

Two watersheds--the Sebasticook River and Kenduskeag Stream--are identified as the main drainage systems receiving agricultural non-point pollution.

Use of agricultural chemicals is an integral part of crop production. Potato growers use 8 to 12 applications of herbicides, fungicides, and insecticides on potatoland each season. Estimates of amounts of pesticides and fertilizers are given for each acre of potatoes, corn, and oats (rotated with potatoes).

Nutrient losses to surface waters are difficult to estimate. Projections are discussed, based on other studies.

Complaints from agricultural chemical use has decreased appreciably in recent years. Disposal of used containers remains a problem. Some recommendations are offered.

Reduction of soil erosion is an indirect solution to chemical runoff. Other specific recommendations should be superseded by measuring the problem.

The enclosed maps indicate the rate and location of soil erosion in the Conservation District. The maps also indicate the number of animal units and their location within a given watershed. A triangular symbol indicates farms with animal manure recycling plans and (as appropriate) animal manure storage facilities meeting SCS Field Office Technical Guide criteria. The total quantity of animal manure produced annually within a given watershed can be approximated by multiplying the number of animal units by the amount of manure produced per animal unit per year.

I. CROPLAND SOIL EROSION APPRAISAL

Background

Soil erosion on cropland has long been a concern to farmers and soil conservationists. Erosion decreases productivity of the land and very subtly reduces the agricultural resource base. The resulting sediment degrades water quality. This erosion appraisal, carried out as part of the statewide Study of Non-Point Agricultural Pollution (SNAP), was designed to locate and show the extent of cropland erosion in the Penobscot County Soil and Water Conservation District (S&WCD), to evaluate its effects on area water quality, and to offer alternative programs to reduce soil loss. This appraisal will assist the Conservation District in setting priorities for carrying out conservation programs designed to solve the worst erosion problems and help protect land and water quality in Penobsct County.

The S&WCD is grateful to John Arno, Soil Scientist, who provided leadership for the SNAP field survey. Special thanks are extended to Christopher Theodor, District employee, for unfailing interest and enthusiasm in carrying out the field work and helping to prepare this report.

Causes of Cropland Erosion

There are two distinct types of agricultural enterprises in the Conservation District: dairy and potatoes. An estimated 15,000 acres of land are used to grow corn and potatoes. A significantly smaller acreage is planted to oats and dry beans. Farmers are faced with maintaining high levels of production while minimizing soil loss. Often, immediate economic gain is chosen over long-term benefits of good conservation practices.

Three natural conditions in Penobscot County create a potential for high rates of erosion: climate, topography, and soils.

Within the climatic area of the Northeast there are many instances when rainfall exceeds the rate or volume at which soil can take in and store moisture. When this happens, surplus water will pass over the land in the form of runoff.

Falling rain and flowing runoff provide the energy needed to erode large quantities of soil from areas under cultivation. One inch of precipitation falling on one acre weighs 110 tons. Raindrops striking unvegetated ground at a velocity of about 19 miles per hour knock soil particles loose while compacting the exposed soil surface.

Climate strongly influences agricultural practices in Penobscot County. Long winters and short growing seasons require that the land be prepared and planted in a short time. Late maturing crops and fall season rains at times preclude establishment of cover crops to protect the land from spring runoff. Most potatoes are harvested between mid-September and mid-October. Frosts usually occur before winter cover crops can be successfully established, particularly on potato fields. Increased size of farm equipment results in soil compaction and encourages farming up and down slopes on steep, narrow fields. Removal of stones during the potato harvesting operation destroys a natural mulch and increases the potential for erosion.

Most of the cropland of Penobscot County is located on Bangor-Dixmont-Thorndike soil association. The association occupies broad, rolling, and undulating ridges of glacial till. Interspersed with these ridges are areas of moderately well-drained, gentle slopes and sharply contoured ridges that are shallow to bedrock with numerous outcrops. Both the deep and shallow glacial till soils are composed of silty materials and are highly erodible during modest rains and snowmelt.

The remainder of this section will quantify the erosion and sediment problem and its effect on agriculture and water quality and will describe the steps necessary to reduce erosion.

Field Procedures for the Cropland Erosion Survey

Two erosion surveyors estimated soil loss on about 13,500 acres of cropland in the Conservation District during 1977. Soil erosion was determined by visiting each cropland field over 10 acres. Cropland was defined as land planted to a row crop at least once in 5 years. Location of cropland and all erosion data were recorded on aerial photographs.

Four factors were evaluated before sheet and rill erosion were computed: 1) soil type, 2) length and steepness of slope, 3) presence of conservation practices, and 4) the current cropping and management practices (crop rotations and cultural methods). Values for these factors, and a factor for rainfall erosion, were entered into the Universal Soil Loss Equation (USLE), the use of which is described in the Appendix. The computed soil loss, expressed as the average number of tons of soil eroded per acre per year over the crop rotation, was then placed in one of six categories and noted on aerial photographs. The six categories are: 0 to 3, 4 to 5, 6 to 7, 8 to 10, 11 to 25, and 26 or more tons per acre per year.

Also recorded on the photographs were major factors influencing soil erosion on each field, including steep slopes, long slopes, poor rotations, and up and down hill farming.

The soil erosion surveyors also checked each field for gully erosion and recorded its occurrence on the same photographs. Washes which could be filled in with ordinary farm tillage equipment were not identified as gullies.

The soil erosion appraisal considered average slope conditions in a field and an estimate of crop management. No attempt was made to interview farmers to determine exact crop rotations and cultural methods. Areas of contrasting soil loss of less than 10 acres within a field were not delineated because of map scale and detail desired in this appraisal. However, these areas were averaged with typical field conditions.

Summary of Soil Erosion by Soil Loss Category

Average soil erosion on the 13,765 acres of cropland in the S&WCD is estimated to be 4.4 tons per acre per year (Table 1). Tolerable soil erosion is defined as the maximum rate of soil erosion permitting a high level of crop productivity on a sustained basis. Tolerable soil erosion for most Maine soils, according to the Soil Conservation Service (SCS), is 3 tons per acre per year, except on some soils where either 2 or 5 tons are considered tolerable. Penobscot County soils are rated in the 2 and 3 tons per acre per year categories.

The average annual soil loss on cropland fields exceeding the 3 ton loss limit is about 6.1 tons per acre per year, or about twice the tolerable soil loss on 7,457 acres.

Annual soil losses range from 2.7 tons per acre per year in Webster Plantation to 9.8 tons per acre per year in Carmel (Table 1). These townships account for less than 2 percent of the surveyed cropland in Penobscot County. More important are the total tons per year lost in each town. Farms in Exeter are losing more soil annually than farms in Corinna, Corinth, Garland, Charleston, and Bradford. In all towns but Corinna, Garland and Bradford, about half of the total cropland acreage falls within the tolerable soil loss group, 0 to 3 tons per acre per year. This is in large part due to applied conservation practices. Another factor accounting for this is favorable soil and slope characteristics. This appraisal did not reveal any cropland losing more than 26 tons per acre per year.

The type and intensity of agriculture varies in Penobscot County. To further aid a discussion of the appraisal results, towns having cropland were grouped according to the type of agriculture.

TABLE 1 - TOTAL SOIL LOSS AND AVERAGE PER ACRE LOSS ON INVENTORIED CROPLAND

Town	Cropland (acres)	Average soil loss* (tons per acre per year)	Total average sheet & rill erosion (tons per year
Exeter	2,696	4.5	12,062
Corinth	1,463	4.5	6,618
Corinna	2,126	4.3	9,099
Newport	722	3.1	2,246
Charleston	1,279	3.7	4,789
Garland	759	6.6	5,011
Orrington	129	6.9	884
Plymouth	146	5.1	746
Etna	158	4.0	632
Carmel	61	9.6	586
Dixmont	334	4.3	1,436
Levant	124	6.6	818
Hermon	95	3.9	373
Newburgh	177	7.1	1,248
Hampden	181	4.1	738
Stetson	418	4.2	1,762
Dexter	498	3.6	1,813
Bradford	749	4.1	3,044
Hudson	60	3.0	178
Lee	545	3.9	2,134
Winn	202	4.2	841
Springfield	175	3.8	657
Webster Plt.	173	2.7	466
Enfield	46	4.7	218
Lincoln	149	3.1	458
Prentiss	204	3.6	732
Carroll	29	5.3	153
Chester	67	5.1	341
Total	13,765	4.4	60,083

* These average soil loss figures were determined by using the mean value for each erosion category and dividing the total acres of each category into the total soil tons lost. Two tons and 15 tons more correctly represent the 0-3 and 11-25 tons per acre per year categories, respectively, based on field experience; therefore, the mean soil loss values for these categories were adjusted. Average soil loss figures were rounded to the nearest tenth.

Group I: The most intensively tilled soils are in central Penobscot County which includes Charleston, Corinna, Corinth, Exeter, Garland, and Newport. This area has both dairy and potato farms. Over 9,000 acres of cropland were inventoried in Group I for soil erosion. Half of this acreage is losing more than 3 tons of soil per acre per year. Except for shallow soils, like Thorndike, 3 tons is the maximum tolerable loss still permitting continued, self-sustaining agricultural production. The maximum soil loss tolerable on Thorndike soils is 2 tons per acre per year. This survey, however, did not determine the percent of cropland acres exceeding the 2 ton loss; therefore, some erosion shown in the 0 to 3 tons per acre per year category is actually greater than should be permitted. It is well known that a majority of the cropland in central Penobscot County is on Thorndike soils. Other soils found within the cropland of this region are Bangor (moderately deep phase) and Dixmont.

About 70 percent of the cropland of the central region is losing under 5 tons per acre per year. This cropland is typified by Thorndike and Bangor (moderately deep) soils. They are characterized by short slopes that extend only a short distance across the field before the direction of slope changes.

About 2,300 acres (30 percent) of the cropland is losing over 6 tons per acre per year. These fields are made up of soils which are also mainly Thorndike and Bangor (moderately deep) and, in contrast to areas losing less than 3 tons per acre per year, these fields lie in rolling topography. The irregular slopes present in these areas make farming on the contour or across the slope more difficult. The shallow depth to bedrock further restricts use of conservation practices such as diversion ditches, as a means of reducing soil loss.

Group II: The second most intensively farmed area is in the towns of Bradford, Carmel, Dexter, Dixmont, Etna, Plymouth, Stetson, Levant, Hermon, Newburgh, Hampden, and Orrington. Most of the cropland is used in conjunction with a dairy enterprise. The farmland of this area is somewhat unique in that it has a number of cropland fields under 10 acres in size, which would add significantly to the overall cropland acreage inventoried. An estimated 80 percent of the 3,130 acres inventoried for soil loss in this area is planted to corn for silage. There are 1,845 acres--or 59 percent of the cropland appraised--losing more than 3 tons per acre per year. The soils are mainly Thorndike, Bangor (moderately deep), and Dixmont. In this area a greater proportion of the soils are moderately well-drained than in Group I.

Thirty percent of the acreage (931 acres) surveyed for soil erosion is losing soil in excess of 6 tons per acre per year. These fields have the same kind of soil as the categories losing less than 5 tons per acre per year, except that the Thorndike and Bangor (moderately deep) soils are irregular and rolling. These fields are difficult to use for row crops without serious soil loss.

Group III: Northern Penobscot County--around Lincoln, Carroll, Lee, Prentiss, Springfield, and Winn--once was intensively farmed with potatoes. Use of land for row crops has declined in recent years. Potatoes, mainly for seed stock, are still grown on about 1,500 acres. A high percentage of this acreage (88 percent) is losing under 5 tons of soil per acre annually. Only 12 percent, or about 190 acres of cropland, is losing more than 6 tons per acre per year. Overall, this area has less erosion than the other two groups. Most of the presently farmed area is on gently sloping, well-drained soil, accounting in part for the small amount of soil erosion in the northern area. Longer crop rotations, used to avoid disease of the potato seed crops, also are beneficial. The most frequent rotation is potatoes one year, oats the next, and hay the third year. This three-year rotation is very effective in reducing soil erosion.

Table 2 summarizes soil loss by category for each town in the Conservation District by group.

Among the three groups, soil erosion at the rate of 4 to 10 tons per acre per year occurs on 52 percent of the cropland in the Conservation District.

Soil erosion on cropland losing more than 3 tons per acre per year is considered excessive. Land losing greater than 10 tons per acre per year represents an extreme problem. A field losing 10 tons of soil per acre per year would lose an inch every 15 years. A field losing 18 tons of soil per acre annually would lose an inch in only about 8 years. This, of course, assumes soil loss to be uniform over an acre and does not include loss from gully erosion.

In the Penobscot County S&WCD approximately 1,500 acres are losing over 8 tons of soil per acre per year. This 11 percent of the cropland generates about 16,000 tons of soil moving on the land each year, or about 27 percent of the soil loss resulting from sheet and rill erosion.

Soil Loss Maps

Maps accompanying this report note the erosion status on all cropland fields greater than 10 acres. Using the maps, soil losses from sheet, rill, and gully erosion can be related to the proximity of the cropland to water bodies and the potential for water pollution can be evaluated. The soil erosion maps can be used to pinpoint the worst soil erosion problem areas and to aid in developing conservation programs to address the problems.

TABLE 2 - PERCENT AND ACRES OF CROPLAND BY SOIL LOSS CATEGORIES

Town	Total cropland (acres)	Soil loss categories (tons per acre per year)										
		0-3			4-5		6-7		8-10		11-25	
		%	Acres		%	Acres	%	Acres	%	Acres	%	Acres
Group I												
Exeter	2,696	47	1,275	T	25	662	12	311	14	368	3	80
Corinth	1,463	46	678	O	15	225	27	400	9	125	2	35
Corinna	2,126	35	763	L	43	904	15	327	5	100	2	32
Newport	722	65	474	E	22	157	13	91	--	--	--	--
Charleston	1,279	67	851	R	14	179	7	94	9	109	4	[illegible]6
Garland	759	31	232	A	21	160	15	112	16	121	18	134
				B								
Totals	9,045		4,273	L		2,287		1,335		823		327
				E								
Group II				S								
				O								
Orrington	129	9	11	I	22	29	55	71	--	--	14	18
Plymouth	146	29	42	L	29	43	22	32	20	29	--	--
Etna	158	53	83		15	23	27	42	5	10	--	--
Carmel	61	--	--	L	16	10	16	10	36	22	31	19
Dixmont	334	47	157	O	26	86	20	67	3	10	4	14
Levant	124	15	19	S	28	35	22	27	27	33	8	10
Hermon	95	39	37	S	41	39	20	19	--	--	--	--
Newburgh	177	--	--		28	50	50	89	12	21	10	17
Hampden	181	48	86	L	21	38	26	47	5	10	--	--
Stetson	418	36	152	I	46	191	15	62	--	--	3	13
Dexter	498	59	294	M	22	108	10	50	9	46	--	--
Bradford	749	49	367	I	32	239	6	45	12	88	1	10
Hudson	60	62	37	T	38	23	--	--	--	--	--	--
Totals	3,130		1,285			914		561		269		101

TABLE 2 - PERCENT AND ACRES OF CROPLAND BY SOIL LOSS CATEGORIES

Town	Total cropland (acres)	Soil loss categories (tons per acre per year)										
		0-3			4-5		6-7		8-10		11-25	
		%	Acres		%	Acres	%	Acres	%	Acres	%	Acres
Group III												
Lee	545	30	165	T	61	333	9	47	--	--	--	--
Winn	202	17	35	O	78	157	5	10	--	--	--	--
Springfield	175	30	52	L	70	123	--	--	--	--	--	--
Webster Plt.	173	72	125	E	28	48	--	--	--	--	--	--
Enfield	46	61	28	R	--	--	--	--	39	18	--	--
Lincoln	149	73	109	A	7	10	20	30	--	--	--	--
Prentiss	204	59	120	B	13	27	28	57	--	--	--	--
Carroll	29	--	--	L	62	18	38	11	--	--	--	--
Chester	67	19	13	E	57	38	--	--	24	16	--	--
Totals	1,590		647	S		754		155		34		--
				O								
Grand total	13,765		6,205	I		3,955		2,051		1,126		428
				L								
				L								
				O								
				S								
				S								
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				M								
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				T								

Note: Total percentages by soil loss categories do not equal 100 because of rounding.

Factors Influencing Soil Loss

The cropland erosion inventories show that 7,560 acres of cropland have soil losses in excess of 3 tons per acre per year. One or two major contributing factors for the soil loss problems were determined for each field during the 1977 SNAP appraisal. Factors which contribute to high erosion rates include steep slopes, long slopes, poor rotations, and up and down hill cultivation. Slopes were considered long if they were 600 feet or longer, and steep if grades were 6 percent or more. Rotations were considered poor if row crops were grown more often than half of the rotation. Table 3 summarizes the major reasons for soil loss from the SNAP appraisal.

TABLE 3 - MAJOR FACTORS INFLUENCING THE EROSION PROBLEM ON 7,560 ACRES OF CROPLAND

Soil loss category (tons per acre per year)	Cropland inventoried in each category (acres)	Factors for soil loss (acres)			
		Steep slopes	Long slopes	Poor rotation	Up and down hill cultivation
4-5	3,955	954	946	1,068	618
6-7	2,051	688	601	293	425
8-10	1,126	394	696	305	414
11-25	428	258	164	67	263
Total*	7,560	2,294	2,407	1,733	1,720
(Percent)		30.3	31.8	22.9	22.8

* More than one factor often was given for soil loss for each field, thus totals of all factors exceed the 7,560 acres of cropland surveyed.

Slope length and gradient are major factors in cropland erosion. If land is nearly level and slopes are short, sheet and rill erosion potential is low regardless of the method of cultivation or length of rotation. As length of slope doubles, erosion increases approximately 1.5 times. As the steepness of slope doubles, erosion increases approximately 2.5 times. On Penobscot County's upland soils, slopes are often 400 to 600 feet long with gradients of 3 to 7 percent. Occasionally slopes will exceed 1,000 feet with segments of fields as steep as 15 percent.

Steep slopes, alone or in combination with other factors, contribute significantly to the erosion problem on about 2,294 acres or 30 percent of the cropland needing conservation. Long slopes are considered a major problem on approximately 2,407 acres.

Continuous row cropping adds significantly to any erosion problem and reduces the productivity of the field. Poor rotations expose soil to the impact of rainfall for a longer period of time resulting in more soil being detached and transported downslope. Productivity is decreased due to poorer soil structure and low amount of organic matter.

A good rotation is valuable in reducing erosion. Most potato growers rotate potatoes with corn for grain on an alternate year basis. Three out of 14 operations in central Penobscot County rotate potatoes and oats, resulting in 26 percent less erosion. About 200 acres of corn for silage are rotated with potatoes in Penobscot County. Erosion is 40 percent greater with this rotation than with potatoes and oats and 19 percent greater than with corn for grain rotated for potatoes. The residue of high moisture ear corn, shell corn, and oats is valuable in reducing erosion.

Among dairy operations it is common to grow silage corn nearly continuously. Based on a 6-year cropping system, a rotation of 3 years of corn and 3 years of hay would reduce erosion by 45 percent, compared to continuous corn. Improved crop rotations would significantly reduce erosion on about 1,733 of the 7,560 acres needing treatment.

Up and down hill cultivation contributes to erosion on nearly 1,720 acres of cropland. Planting up and down hill allows water to flow unrestricted the length of the slope, developing velocity and increasing erosion to the point that rills and gullies form in the field.

Conservation measures have a great value in reducing erosion. Planting across slope or on the contour in effect creates ridges which reduce runoff by allowing more water to infiltrate into the soil. Table 4 shows the expected percent reduction in erosion if various alternatives to up and down hill cultivation are adopted. The effectiveness of these practices in the control of erosion is reduced as slope gradients increase. Diversions and stripcropping are necessary to control runoff water and reduce erosion on steeper slopes.

When soil loss exceeds 8 to 10 tons per acre per year, gully erosion becomes a serious threat. For gullies to form, runoff must be concentrated, usually in a natural depression. Gullies can form in fields with a lower average soil loss if excess water has been diverted to an undersized waterway.

Generally, gully erosion on cropland is not as serious a problem in the Penobscot County S&WCD as sheet and rill erosion. It has been observed that most potential gullies are filled by cultivation before they become so deep that fields cannot be easily worked with large equipment.

Approximately 800 feet of active gullies were noted during the erosion study. Some natural waterways are gullying as a result of concentrated runoff from adjacent fields. Accompanying soil loss maps show the location and extent of gully erosion.

TABLE 4 - PERCENT REDUCTION IN SOIL LOSS DUE TO CONSERVATION PRACTICES 1/

Slope (percent)	Cross slope farming without strips	Contour farming	Cross slope farming with strips 2/	Contour strip-cropping 3/
2.0-7	25	50	63	75
7.1-12	20	40	55	70
12.1-18	10	20	40	60
18.1-24	5	10	33	55

1/ USDA-SCS Field Office Technical Guide.

2/ These values also may be used for 3-year rotations of row crops, small grain, and meadow, providing crops are grown in equal width strips.

3/ This practice refers to equal width strips with row crops, alternating with sod or meadow crops.

Effects of Sheet, Rill, and Gully Erosion on Agricultural Production

The short term effects of erosion include loss of nutrients, loss of valuable water for plant production, and degradation of soil structure resulting in reduced yields and poor quality crops. Deposition of silt and clay at the base of slopes also makes the use of heavy machinery difficult during wet periods because of muddy conditions. Large rills require more management to prevent them from becoming gullies.

Long term effects of erosion include decreased yields and reduced crop quality both of which may result in lower economic return to the farmer. Erosion also slowly decreases the resource base by removing topsoil and rendering some land useless for growing crops. Erosion problems are most serious on soils which are shallow to bedrock because relatively small losses of soil may eventually expose more bedrock and possibly prevent further use of these fields for row crops.

Effects of Sediment on Water Quality*

Sediment is by volume the largest single pollutant of surface waters. Sediment reaching major streams in the United States is reported to average at least 4 billion tons a year, with half the volume originating on agricultural land.

Excess sediment can pose numerous hazards to surface waters. It can harm fish and fish habitat, increase the cost of filtration of drinking water, destroy the aesthetics of surface waters, and reduce the capacity of reservoirs used for water supply, flood control, and recreation. Soil particles often carry pesticides, fertilizers, and other chemicals. The section on Agricultural Chemical Use and Disposal considers the role of pesticides and nutrients in detail.

Sediment has numerous detrimental effects on the aquatic life of a stream including: decreased production of plant life due to darkened water, decrease in the effective feeding of trout and salmon resulting from less light penetration, and abrasion of fish gills by suspended solids.

As sediment accumulates it damages fish spawning beds and nursery areas and habitats of aquatic insects.

Fertilizers are carried from eroding agricultural land into lakes and streams, either attached to soil particles or dissolved in runoff. Algae and larger aquatic plants thrive on these nutrients. Decomposition of this excessive organic matter can deplete dissolved oxygen, killing fish and creating unpleasant odors. Summer fishkills on selected farm ponds are indicators of the harmful effects of excessive nutrients in water bodies. Biologists feel that these fishkills are a result of dissolved oxygen problems created by nutrient-rich sediments which in part originate from erosion of cropland.

Each year tons of pesticides are applied to crops in Penobscot County. A variety of herbicides, fungicides, and insecticides are aerially and ground sprayed. The effects of many of these chemicals on our aquatic environment are not known.

Other Effects of Sediment

Ditches along rural roads adjacent to fields with high soil losses often fill with sediment. Some of this sediment is from agricultural land. It is estimated that several hundred cubic yards of sediment are removed from ditches in the area each year at taxpayers' expense.

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* Most of this section was taken from the Aroostook Prestile Areawide Water Quality Plan, prepared by the Northern Maine Regional Planning Commission.

Sediment Yield to Surface Waters

Not all eroded material reaches area water bodies. Much is deposited in depressions or is filtered out by natural barriers such as wooded or grass filter strips. Road ditches also can collect large volumes of sediment from adjacent cropland. The percentage of the sediment from all sources (including gullies, roadsides, and streambanks) which reaches a point in a stream system is referred to as the sediment delivery ratio (Appendix). Where this ratio is known or can be closely approximated, the sediment yield is estimated by computing total erosion and multiplying it by the sediment delivery ratio.

Since no two watersheds are exactly alike, the amount of sediment reaching surface waters varies. Rainfall, drainage area, soils, stream gradient, and proximity of cropland to waterways influence the amount of sediment delivered to rivers and ponds. Size of the drainage area is important in sediment transport because the distance to downstream points is greater in larger watersheds and the opportunities for deposition are more numerous.

Approximating a 15 percent average delivery ratio for the Conservation District, about 9,000 tons of sediment from agricultural land and some amount of farm chemicals reach area water bodies annually. The amount of farm chemicals attached to this sediment is not known.

Land Treatment or Changes in Land Use Needed

More than 7,500 acres of cropland in the S&WCD need some form of land treatment to reduce erosion to 3 tons per acre per year. The 3,955 acres of cropland in the 4 to 5 tons per acre per year class can be reduced by one or more conservation practices, such as cross slope farming, contouring, or improving the rotation. As soil losses become greater, more complex cropping systems are needed. For example, the 3,177 acres in the 6 to 7 and 8 to 10 tons per acre per year classes need a combination of conservation practices to reach a 3 ton soil loss rate. Conservation cropping system* practices include stripcropping, contour cultivation, cross slope farming, a good rotation, cover crops, waterways, diversions, and other practices. The number and combination of these practices depend on the severity of the erosion problem and the goals and desires of the farmer.

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* A conservation cropping system entails growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops. From: SCS Field Office Technical Guide.

A complex conservation cropping system is required on land losing 11 to 25 tons of soil per acre per year. In the S&WCD there are 428 acres in this category. The practices necessary on this land are the same as those needed for land in the lesser soil loss classes; however, they must be applied more frequently and/or intensively. Diversions are important in controlling runoff on this land because they reduce the length of slope, allowing cultivation on the contour and strip-cropping to reach tolerable soil loss limits. If erosion on all crop-land could be reduced to 3 or less tons per acre per year, an estimated 47,600 tons of soil would be saved each year.

Effects of Conservation Practices on Water Quality

Use of conservation practices would not only increase the longevity of cropland for food production, but also would improve water quality. The application of soil conservation practices to the estimated 7,500 acres of cropland needing treatment would substantially reduce the volume of sediment and related chemicals delivered to surface waters.

Alternative Solutions

Applying conservation to the land is the best way to protect Penobscot County's soil and water resources.

Over the past 40 years, conservation programs have been voluntary, based on information, education, and incentives in the form of technical assistance and federal cost-sharing for conservation practices. As a result of past and present efforts, conservation is being applied to the land. Continued but intensified efforts are required to meet needs.

Possible incentives to encourage voluntary farmer action which deserve consideration include: 1) increased annual cost-sharing for needed structural conservation practices, 2) local tax relief to farmers who place land in soil conserving crops such as oats and hay, 3) federal income tax relief for land removed from row crops, 4) cost-sharing for diversions and waterway maintenance, and 5) increased technical assistance to help landowners solve their erosion problems.

Improved rotations on cropland could substantially reduce damage from erosion. Introduction of legumes such as alfalfa into rotations on cropland on well-drained Thorndike and Bangor soils of Penobscot County could be beneficial to both dairy and potato farmers. In instances where these two types of farms cooperate, the legumes would:

1. Reduce erosion to the benefit of both farms.

2. Introduce nitrogen into the soil, benefiting any future crops.

3. Make locally grown high protein feed available to the dairy farmer.

4. Raise organic levels in the soil.

Alfalfa is an important source of haylage, a high protein cattle feed. A local source of high protein feed might be advantageous to farmers who now have to import this protein from other parts of the country. The economics of using legumes in rotation should be researched to determine its feasibility.

Cover crops have been tried recently on corn silage ground in Penobscot County. About 500 acres of corn were aerially seeded with winter rye early in August 1977. These cover crops are presently being evaluated to determine their success. Evidence so far, although premature, looks promising. This program is presently cost-shared by the Agricultural Stabilization and Conservation Service (ASCS). More farmers need to try winter rye on eroding cropland.

The Cooperative Extension Service has been active in disseminating information about conservation practices, particularly agronomic remedies for eroding corn land. Recommended chemical dosages for weed control should be more closely followed by farmers. Reduction of chemical rates could reduce the overall cost of producing the crop, as well as encouraging late season weed cover to protect exposed soil.

Conclusions

An inventory of erosion on cropland fields 10 acres in size or larger was conducted in the Penobscot County S&WCD in 1977. The following conclusions resulted from the appraisal.

- The average countywide soil erosion is 4.4 tons per acre per year for 13,765 cropland acres.

- More soil is lost in the town of Exeter than any other Penobscot County town.

- Central Penobscot County is the most intensively farmed area within the Conservation District. Principal crops are corn and potatoes. About half the 9,045 acres inventoried in this area are losing more than 3 tons of soil per acre per year.

- Slope length and gradient are the principal reasons for soil loss on 62 percent of the cropland appraised.

- Field observation did not indicate widespread gully erosion.

- More than 7,500 acres of cropland in the S&WCD need some form of land treatment to reduce erosion to 3 tons per acre per year. About 4,000 acres can be reduced to the 3 ton tolerable limit by applying one or more practices. More severely eroding fields require combinations of practices to reduce soil loss to tolerable amounts.

- An estimated 47,600 tons of soil would be saved annually if conservation practices were applied to cropland losing more than 3 tons per acre per year.

- Farmers developing and following soil and water conservation plans will more effectively and efficiently achieve erosion and sediment control and improved water quality.

- Increased technical assistance is needed to help landowners solve erosion problems.

- Increased financial assistance without annual limitation is needed to help landowners solve erosion problems.

II. ANIMAL MANURE STORAGE AND DISPOSAL APPRAISAL

Animal Manure as a Potential Water Pollutant

As the cost of fossil fuels rises and commercial fertilizers become more expensive, the use of natural fertilizers becomes more popular. More and more the value of animal manure is being realized. Purdue University conducted a study of the nutrient content of cow manure and its value to dairymen, comparing nutrient value of manure packs vs. open lots vs. lagoons. Researchers found that manure pack nutrients from a 1,000-lb. cow are valued at $35.52 annually if promptly plowed under. Weather-exposed, open lot manure from the same animal is worth $19.88.* Manure values were measured against costs of the same nutrients in commercial fertilizer. The following chart, reproduced from "Tons O' Gold!", shows the value of manure for the different handling methods.

NUTRIENT VALUE OF MANURE PER YEAR FROM A 1,000 LB. ANIMAL

Manure pack, plowed under	Open lot, plowed under	Lagoon irrigation system
$14.56 N (Nitrogen)	$ 7.96 N	$ 3.68 N
12.00 P (Phosphorus)	7.20 P	3.36 P
8.96 K (Potassium)	4.72 K	6.40 K
$35.52	$19.88	$13.44

The problems of handling animal manure are closely related to short season crops and long winter confinement (up to six months) for livestock. Spreading of livestock and poultry manure on cropland, hayland, or pastureland when the ground is snow-covered or frozen is not recommended, according to the "Maine Guidelines for Manure and Manure Sludge Disposal on Land". Applications are further restricted to times when the manure won't injure plants or prevent animals from grazing. Thus, the proper storage and management of manure in Maine is a challenging problem to overcome.

Open-stacked manure has the greatest potential for becoming a non-point source water pollutant. When rapid snowmelt and heavy spring run-off occurs, manure piles are highly susceptible to transport into nearby waterways. Occasionally, open access of large numbers of livestock to brooks and streams may cause pollution hazards. Spreading of manure along flood plains is a greater threat to over-all water quality.

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* Stoddard, Carlton D. 1977.

Nitrogen, phosphorus, and potash are the main nutrient components of animal manure. When improperly spread or incorporated into the soil, these nutrients are threats to maintaining or improving the quality of surface waters. When the rate of spreading exceeds the particular soil's and plant's ability to absorb and hold nutrients, surface runoff and subsurface nutrient leaching occurs. Spreading manure on flood plain soils, which characteristically are flat and adjacent to surface waterways, can lead to immediate and direct contamination of the water resource.

Pollution of water by animal manure can sometimes create health problems for man, livestock, and potential disease problems for aquatic life. Bacteria, viruses, protozoans, and fungi are among the potential pathogens that are difficult to detect in all types of animal manure and water. These are primarily of concern only in drinking and swimming water.

Most normal, sanitary agricultural operations where manure is properly spread or stored greatly reduce the potential for pollution. The easily detectable fecal coliform bacteria which are present in all warm blooded animals are used only as an indicator of the degree of health risk involved for swimming or drinking water which may be contaminated by animal manure. The degree of risk and pollution potential varies depending on the type and amount of fresh animal manure reaching the water.

Nutrients in animal manure include nitrogen and phosphorus compounds. These compounds are present in relatively high concentrations and where animal manure is not incorporated into the soil (i.e., stockpiled or spread), potential for high nutrient concentrations in surface runoff is high. Proper land spreading, based on soil types and soil incorporation methods, must be used to prevent excessive nutrients from leaching into ground water.

Nutrient enrichment of lakes and ponds can accelerate eutrophication or aging. This can result in excessive algae and other aquatic plant growth causing undesirable taste, odor, and aesthetic problems, decreasing the value of lakes and ponds for recreation. When these plants die, toxins are produced and oxygen is depleted. Fishkills can result in severe cases. In addition, high levels of nitrate and nitrate nitrogen in ground water used for water supply can cause methemoglobinemia, an uncommon blood disorder in infants. This may be of concern where wells or ponds are used for drinking which may be located near barnyards or manure piles.

General Description

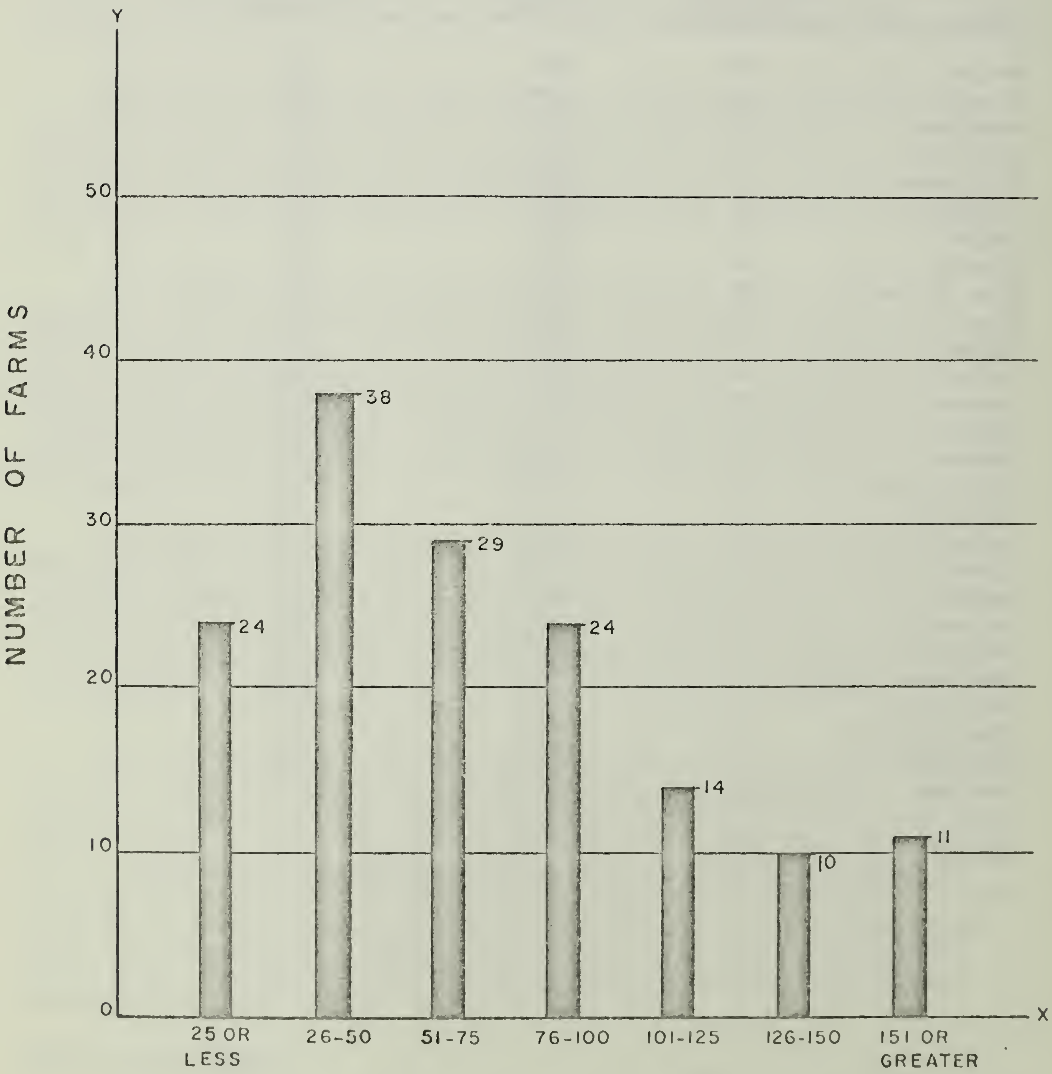
Dairy and poultry are the main livestock enterprises in the Penobscot County Soil and Water Conservation District (S&WCD). There are 126 dairy operations in the District with greater than 25 animal units (AU) (Table 5). Graph 1 shows the numerical distribution of

TABLE 5 - SUMMARY OF DAIRY ANIMAL UNITS (AU)

Town	Farms with over 25 AU (number)	AU (number)	Maximum AU on any one farm (number)
Bangor	10	864	195
Alton	1	56	56
Bradford	11	1,187	225
Carmel	2	87	46
Charleston	7	828	195
Corinna	14	1,122	157
Dexter	14	992	170
Dixmont	4	613	257
East Corinth	10	470	75
Etna	2	108	66
Exeter	6	491	187
Garland	6	470	110
Hampden	5	401	123
Hermon	5	451	145
Hudson	1	81	81
Kenduskeag	3	489	300
LaGrange	1	52	81
Levant	6	431	120
Lincoln	5	224	57
Medway	0	21	11
Newburgh	7	590	110
Newport	6	454	210
Old Town - Orono	0	102	180
Orrington	2	190	190
Passadumkeag	1	47	47
Plymouth	2	135	100
Stetson	4	162	50
Totals	135	11,118	

GRAPH No. I

NUMERICAL DISTRIBUTION OF DAIRY ANIMAL UNITS BY FARM IN THE PENOBSCOT COUNTY S.W.C.D.



ANIMAL UNITS (DAIRY)

dairy animal units. There are fewer than half a dozen beef operations exceeding the 10 AU category Of the 33 poultry enterprises in the Conservation District, poultry animal units range from 28 to 728 (Table 6).

Dairy animal units average about 72 per operation. Herd size has been increasing over the last few years. The trend is to milk larger numbers of cows. The high cost of energy and available land resources should stabilize the growth of the herd size in the future. However, from the farmers' viewpoint herd size will probably increase in order to sustain or increase cash flow. The difficulty arises when improper development of these resources exceeds the land's carrying capacity.

TABLE 6 - SUMMARY OF POULTRY ANIMAL UNITS (AU)

Town	Farms with over 10 AU (number)	AU (number)	Maximum AU on any one farm (number)
Carmel	3	236	92
Charleston	1	48	48
Corinna	6	728	200
Corinth	5	560	120
Dexter	3	280	104
Dixmont	1	136	136
Etna	3	492	240
Hermon	2	180	112
Kenduskeag	1	72	72
Levant	1	124	124
Newburgh	2	220	168
Newport	1	240	240
Plymouth	3	640	348
LaGrange	1	28	28
Totals	33	3,984	

Methods

The numbers and locations of animal units were obtained from knowledge of local technicians, Agricultural Stabilization and Conservation Service (ASCS) records, and telephone contacts with the farmers. The following chart shows how animal units are calculated.

ANIMAL UNIT EQUIVALENTS (AU)

1 -	1,000-pound bull or cow	equals	one	animal	unit
2 -	500-pound heifers	"	"	"	"
1 -	1,000-pound horse	"	"	"	"
7 -	140-pound sheep	"	"	"	"
14 -	70-pound lambs	"	"	"	"
250 -	4-pound chickens	"	"	"	"
3 -	330-pound hogs	"	"	"	"

Note: A thousand pounds of animal(s) live weight represent an animal unit. An 1,800-pound cow equals 1.8 AU.

The locations and numbers of animal units greater than 10 were marked on base maps (1:50,000 scale). In addition, the acres available for spreading poultry manure were indicated also. This information was obtained, initially, by talking directly to poultry farmers. Since most poultry manure is used by dairy farmers, they were contacted to determine the actual acres used for spreading.

Kinds and Amounts of Manure

Estimates of livestock and poultry manure vary. Nutrient contents vary also, due to climate, production methods, type of feed and measurement techniques. As domestic animals vary in size, so does the amount of manure they generate. Adult dairy cattle range in weight from 1,000 to 1,500 pounds per animal; beef are 800 to 1,000 lbs; horses - 1,000 to 1,200 lbs.; swine - 100 to 200 lbs.; laying hens and broilers - 4 to 5 lbs. Table 7 summarizes the daily production and composition of fresh livestock and poultry manure. The upper figure in each tabulation represents the average production of fresh manure for each 1,000 lbs. live weight animal. The lower figure gives the range of values.

Table 8 shows the estimated pounds of nitrogen and phosphorus generated annually through animal manure within the Penobscot County SWCD.

TABLE 7 - DAILY PRODUCTION AND COMPOSITION OF LIVESTOCK MANURE (feces and urine)*
(Upper figure is average; lower figure represents the range given in literature. Dashes indicate data not available or entry not appropriate)

	Dairy Cattle	Beef Cattle	Feeder Swine	Breeder Swine	Poultry	Ducks 1/	Sheep	Horses
			lb/day/1,000 lb live weight					
Manure	85 72-90	62 41-88	69 50-90	50	53 32-67	---	36 30-40	50 40-60
Total solids	9.3 6.8-13.5	8.9 6.0-11.1	7.2 6.0-9.0	4.3	13.9 9.0-17.4	24 2/ 13-31 2/	9.5 8.4-10.7	17.5
Volatile solids	6.9 5.7-7.9	6.9 4.8-8.2	5.7 4.0-7.0	3.2	10.8 8.0-12.9	14.5 2/ 8.7-17.5 2/	8.0 6.0-9.1	---
BOD	1.4 0.8-1.8	1.5 1.0-1.8	2.3 2.0-2.8	1.3	3.4 1.6-5.5	5.1 4.1-7.6	0.8 0.7-0.9	1.4
COD	8.4 4.2-13.3	7.9 6.6-9.0	5.9 4.7-7.1	5.2	12.5 9.5-15.8	---	10.0 7.5-12.0	---
Total nitrogen as N	0.37 0.29-0.51	0.43 0.30-0.58	0.45 0.20-0.70	---	0.86 0.45-1.50	1.42 1.17-1.62	0.40 0.34-0.45	0.30
Total phosphorus as P	0.069 0.026-0.100	0.090 0.023-0.170	0.17 0.09-0.27	---	0.40 0.20-0.75	0.62 0.4-0.9	0.075 0.040-0.120	0.12
Total potassium as K	0.20 0.08-0.35	0.23 0.11-0.38	0.25 0.10-0.60	---	0.35 0.12-0.50	0.9 0.6-1.2	0.32 0.24-0.40	0.25

1/ Based on production figures per 1,000 ducks and assuming an average weight of 4 pounds per duck on swim water.

2/ Suspended solids.

* From Agricultural Waste Management Field Manual, SCS

TABLE 8 - ESTIMATED POUNDS OF NITROGEN AND PHOSPHORUS GENERATED DAILY FROM LIVESTOCK AND POULTRY MANURE

Animals	Animal Units (1,000 lbs.)*	Animal manure (pounds)	Nitrogen (pounds)	Phosphorus (pounds)
Dairy	11,000	935,000	4,070	759
Poultry	4,000	212,000	3,440	1,600
Beef	200	12,400	86	18
Horses	100**	5,000	30	12
Sheep	100**	3,600	40	8
Swine	50**	3,450	23	9
Totals	15,450	1,171,450	7,689	2,406

* Rounded to the nearest 100.
** Estimated.

Within Penobscot County there is a good geographical mix of poultry and livestock (dairy). In the process of talking to both the poultry and dairy producers, it became quite evident that poultry manure is highly prized and sought after by dairymen. The maps, attached to this report indicate the number of acres used in spreading this manure. This study indicated that only one poultry operation was not making the manure available for spreading on agricultural fields.

Nutrients from Animal Manure

The concentrations and amounts of nutrients (nitrogen and phosphorus) actually reaching ground and surface water as a result of improper animal manure management are extremely difficult to estimate. Amount of pollution is a function of kind and amount of manure, bedding practices, feeding practices, disposal method, and location of disposal activity with respect to soils, surface water, and amount of rainfall.

Studies conducted in the Cobbossee Watershed District (Kennebec County) in connection with "208" water quality planning showed that 10 percent of all animal-related phosphorus produced in the watershed eventually reached the lakes. Phosphorus runoff from manured fields averaged 1.43 $\pm$ .36 pounds per acre per year. Excessive phosphorus runoff of animal manures was found to be primarily the result of inadequate winter manure disposal and/or storage.

Nutrient loading to nearby streams and ground water is influenced by the type and amount of manure. Certainly, all these nutrients do not reach area waterways. Some are used during normal decomposition and some will be used by plant growth where manure is spread. Runoff from rains and snowmelt can transport 10 to 20 percent of the nitrogen and phosphorus found in manure which has been spread on frozen or snow-covered fields.*

The location of stockpiled manure influences potential water pollution. Slope and soil characteristics of the site determine whether nutrients will be easily leached with ground water or rapidly carried into surface waters. If manure is stockpiled near surface water, nutrient loss and contribution to the water resource will be substantially greater than the 10 to 20 percent cited above. The "Maine Guidelines for Manure and Manure Sludge Disposal on Land" recommends that manure be spread only where slope is less than 25 percent. Rates are specified according to soil type. No spreading is recommended within 25 feet of wells, springs, ponds, lakes, or marine waters. Location of manure stockpiles is also recommended for only certain soils. These stockpiles are not to be left for more than one year and must be located more than 300 feet from any surface water.

Lack of specific research and the extreme variation in amounts, type, location, and method of animal manure management make it difficult to generally estimate nutrient loads contributed by improper animal manure management. To protect water quality--especially ground water used for water supply--steps must be taken to assure development of animal manure recycling plans and appropriate construction of adequate storage facilities (or other methods of treatment of animal manure) by livestock farmers.

<u>Extent of Dairy Manure Problems</u>

There are only two dairy farmers in Penobscot County S&WCD which have manure storage facilities meeting the standards and specifications of the Soil Conservation Service. Neither storage or spreading appear to be a problem where these systems are operating. There are, in contrast, several areas within the District where both storage and spreading techniques are inadequate and these represent a potential pollution hazard.

Although spreading manure on snow-covered or frozen ground is not popular with farmers, sometimes it is chosen as a means of disposal. There are still some farmers spreading during the winter months. A random survey of 6 percent of the dairy farmers in Penobscot County indicates that about 44 percent of 157 dairy operators spread manure on frozen or snow-covered ground. This study did not determine the number

* Agricultural Research Service, 1975.

of farmers spreading manure on frozen or snow-covered ground when the field lies next to streams or bodies of water.

Examples of known problems associated with storage include:

1. One dairy operation is using soils adjacent to a flood plain to spread manure.

2. There are 19 dairy operations with manure piles within 300 feet of a perennial brook or stream.

3. In one instance the dairy manure pile is within 50 feet of a perennial waterway.

4. One poultry farmer is storing the chicken manure in the open. Because of the poor site selection, the manure is susceptible to runoff to an intermittent drainageway.

5. Between 40 and 50 farmers need stacking pads to facilitate timely removal and spreading of manure.

6. Very few farmers incorporate the manure by plow-down within a short period of time. There are many instances where plow-down does not take place until 4 to 6 weeks later on cropland.

There are an estimated 12 to 15 dairy farms in immediate need of manure storage facilities. These are in close proximity to water bodies or water courses. An approximate cost for each of these facilities would range from $20,000 to $25,000. About $300,000 is needed to solve the worst storage problems. A staff person would be needed to assist the farmers in developing a complete manure recycling management plan. The additional cost would range between $20,000 and $25,000. The cost of developing manure stacking facilities for an additional 40 to 50 dairy farms at an average cost of $10,000 would range from $400,000 to $500,000. The total technical and financial expense for solving the high priority animal manure problems in the Penobscot County S&WCD would range from $720,000 to $825,000.

Recommended Solutions

- Additional cost-sharing is required for construction of the needed manure pits. The present level of cost-sharing through ASCS-ACP ($2,500 maximum) is inadequate. Many farmers, if required to build manure pits at today's costs, could be forced out of business. A companion loan program for farmers to match the federal cost-share would be highly desirable. This available money should not count against the loan value of the farm. A regulatory program could have disastrous effects if enacted without adequate cost-sharing and technical assistance.

- If funding for manure storage facilities becomes available, Soil and Water Conservation District Supervisors will have to establish priorities. These facilities should meet the criteria of the USDA SCS Field Office Technical Guide.

- Continue to emphasize to landowners the importance of following the "Maine Guidelines for Manure and Manure Sludge Disposal on Land."

- When poultry and livestock manure is stockpiled on agricultural land, sites should be located according to the "Maine Guidelines for Manure and Manure Sludge Disposal on Land."

- When storage piles are a problem, technical assistance should be given to landowners to find suitable sites.

- All livestock farms should develop manure recycling plans and establish, as needed, manure handling and storage facilities.

- Manure should be plowed down as soon as possible after spreading on cropland.

Extent of Poultry Manure Problems

There are adequate acres for spreading poultry manure. The primary problem is that the manure is, at times, stockpiled in the field long before spreading. When the site is ill-suited for storage, manure runoff becomes a problem. Except for one instance, this study did not identify any serious misuse or mishandling of poultry manure. In one instance, manure was being stored outdoor in a drainage way and this represented a serious problem. This is not to say that other problems do not exist elsewhere.

Treatment Needs

This study identified only one poultry enterprise which appeared to have adequate storage, but the manure resource was being mishandled. Arrangements should be made with crop farmers to recycle manure.

Animal manure spread on strongly sloping snow-covered fields causes water pollution.

Soil erosion destroys the ability of land to produce crops and causes water pollution. Soil erosion increases the chance of pesticides and chemical fertilizers causing water pollution.

III. AGRICULTURAL CHEMICAL USE AND DISPOSAL APPRAISAL

Agricultural Chemicals and Non-Point Pollution

There are two potentially hazardous effects of agricultural chemicals (pesticides and fertilizer) on water quality. First, chemical concentrations exceeding critical levels can make water toxic to humans, animals, and aquatic organisms. Second, accelerated eutrophication (aging) of ponds can be caused by excessive nutrient levels contributed by chemical fertilizers. Highly eutrophic ponds and lakes can have conditions which result in fishkills due to decaying aquatic plants. Most fishkills are caused by contamination of streams and ponds by improper handling of pesticides. Other effects of these chemicals on the environment are not well understood.

Use of pesticides and chemical fertilizer has increased dramatically in recent years. From 1963 to 1969 there was a 37 percent increase in synthetic pesticide production. From 1950 to 1968 nitrogen production (for fertilizer) increased sevenfold, while phosphorus production doubled.*

Economic benefits and environmental costs of using agricultural chemicals are being thoroughly examined and as information about pesticide use becomes available, it is being offered to the public.

While transport of both pesticides and fertilizer from cropland to ground and surface water is similar, the mechanisms by which these chemicals react to create polluted conditions vary.

Specific effects of fertilizer and pesticide compounds in water will be briefly discussed, followed by a description of the transport methods by which chemicals can enter ground and surface water. This text will be necessarily brief and general; sources listed at the conclusion of the report can be reviewed for more detail.

Effects of Nutrients

Low-level enrichment of some streams and lakes can increase their biological productivity. However, concern arises when concentrations of phosphorus are artificially raised far above "natural" levels which accelerates eutrophication.

Surface waters can be enriched by nutrient losses from cropland. Such losses by erosion depend on location and land use.

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* Agricultural Research Service, 1976

A complete chemical fertilizer contains three major nutrients: nitrogen, phosphorus, and potassium. Uptake of fertilizer nutrients by crops is often no more than 30 percent efficient.

Commercial fertilizer is not the only source of nitrogen available to plants. All organic matter, when decomposed, releases nitrogen to the environment. In addition, it is added to the soil by nitrogen fixation. Nitrate, the available plant nutrient, can be converted to free gaseous nitrogen by the process of denitrification.

The toxic effect of excess nitrate nitrogen in drinking water is well known; above 10 parts per million, water is unfit for drinking purposes. Because of their high solubility, it is easy for nitrate ions to enter ground water. However, the source of the nitrate must be extremely localized before it represents a drinking water hazard.

Excessive concentrations of both nitrogen and phosphorus are thought to be responsible for eutrophication or accelerated growth in surface water ecosystems. Phosphorus especially can stimulate growth, as it is usually a limiting nutrient. Excessive aquatic plant and algae growth can cause difficulties and increased costs in water treatment, taste and odor problems in public water supplies, and negative effects on aesthetics. A problem with accelerated eutrophication, especially in small ponds, is decomposing organic matter which depletes the dissolved oxygen in the water (and may also produce toxic compounds) so that fish may not survive.

Effects of Pesticides

Pesticides can be toxic in aquatic ecosystems and degrade water quality. The movement of pesticides used on cropland is generally horizontal rather than downward through the soil profile. Therefore, the greatest effect of pesticides is on surface rather than ground water. Except in sandy soils, excessive water is needed to move pesticides deep into the soil. It is unusual to find pesticides in the soil below two feet. The exception is found in improper container disposal (burial or dumping) which may result in ground water contamination. This is a problem associated with use of pesticides and is discussed later.

The most visible results of pesticide contamination are fishkills. These are usually due to high concentration of chemicals entering a water body during a short period of time, i.e., rainfall runoff following pesticide application, or spill of chemicals into a water body. However, fish and other stream organisms usually repopulate quickly if habitat is not destroyed and pesticides do not persist.

Pesticides also may have a more subtle effect on aquatic ecosystms if present at low levels over a long period of time or if pollution occurs often. Behavior and reproduction of fish may be affected by this "chronic toxicity". Biological magnification may occur in the case of persistent pesticides, such as organochlorines, which degrade at a very low rate and become concentrated in organisms high on the food chain.

Other long term effects of pesticides on the aquatic environment are difficult to predict. Decomposition of pesticides occurs by chemical reactions, evaporation, or sunlight near the surface and is extremely variable. The organophosphorus pesticides used widely today break down within 8 to 12 days and may never reach surface waters. However, they are extremely toxic when fresh which makes proper storage, handling, and application important. Compounds that are insoluble may reach water bodies by erosion and sedimentation. Properties of the pesticides, soil types, time between application and rainfall, method of application (soil incorporation, leaf, aerial), topography, and land management practices all will affect the amount of pesticides reaching water.

Transport Methods

Nutrients and pesticides reach ground and surface waters in three major ways: runoff, erosion, and leaching. Pesticides, especially when aerially sprayed, also may reach surface waters by drift of air currents.

Agricultural chemical concentrations in runoff waters depend on the amount of time between application and rainfall, soil moisture, proximity of a watercourse, persistence of the chemical, the amount used, method of application (soil, leaf), topography, and soil erodibility.

Soluble compounds will move into soil and ground water by leaching or percolating through the soil. Some pesticides are not very soluble and not subject to much leaching. However, nutrients, especially nitrates, are very soluble and may appear in ground water. A study of nitrates in agricultural soils in northern Maine shows that excessive applications result in higher levels of nitrate in soil solution. Also, there is a substantial peak of nitrate concentration in soil solution in early spring before planting. Much of this nitrate is lost to ground water before crops have a chance to use it.* It is also thought that very little phosphorus moves into a soil as it is relatively insoluble.

There is little evidence that pesticides sprayed on cropland move more than two feet below the surface. However, research has shown that pesticides from containers buried in a landfill (as recommended by the State for a disposal method) do move in the soil to ground water.

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* Rourke, Robert V. 1973-1977.

In 1975, pesticide containers were crushed and placed in a pit 6.1 by 15.2 meters and 1.5 meters deep. Chemicals included Dinoseb, Endosulfan, and Azinphos-Methyl, all commonly used on potatoes. Results to 1977 show that chemicals are moving into the ground water.* Dinoseb and Azinphos-Methyl are more mobile than Endosulfan. Although this landfill method of disposal is generally recommended, the results of this experiment indicate need for research into alternative container disposal methods.

Insoluble pesticide compounds, and to some extent phosphorus, attach to soil particles and are transported to waterways by erosion and sedimentation. Once in water, different variables determine whether the chemical will remain attached to the sediment, be freed into the water or atmosphere, or be assimilated by organisms.

Transport methods and effects of these chemicals on aquatic ecosystems are not completely understood. The greatest unknown is the effect of various combinations of pesticides used in a single watershed. Often two chemicals reacting together cause much greater stress on the environment.

A satisfactory method must be found for disposal of pesticide containers. The present practices of piling containers in a dump, or burying, or simply leaving them in or near the source of water used in the sprayer are all unsatisfactory. These result in contamination of surface and ground water. Incentives to promote compliance must necessarily be incorporated in any new disposal method.

Local Situation

The most intensively farmed area of the Penobscot County Soil and Water Conservation District (S&WCD) is near Exeter. The principal cultivated crops are potatoes and corn. About 6,400 acres of cropland, countywide, are used to grow potatoes in a 2-year rotation with corn or oats. An additional 6,700 acres are used to grow corn for silage, most of which is grown continuously. According to recent records from the Agricultural Stabilization and Conservation Service (ASCS) there are about 15,500 acres of land in rotation with row crops. Hay and pasture are not included.

Distribution of cropland appears on maps accompanying this study. A numerical breakdown of cropland acreage by crop is shown in Table 9. Potatoes for table stock or chips are rotated each year with either oats or corn. Potatoes for seed, particularly in northern Penobscot County, are rotated with oats and clover. There are about 1,500 acres of potato ground in the northern section of the County.

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* Rourke, Robert V., et al, 1975-1977.

TABLE 9 - PRINCIPAL CROPS AND ACREAGES IN ROTATIONS 1/

		Crops in Rotation with Principal Crops (acres)						
			Corn					
Principal crops	Total acreage	Potatoes	Silage	Shell or HMC 2/	Oats	Beans	Rye or Hay	Total acreage in rotations
Potatoes	6,431	No rotation 3/ (acreage unknown)	200 4/	1,635	578	46	556	3,015
Corn	9,033	1,635 (HMC 2/ or Shell)	No rotation 3/ (6,220 4/)	No rotation 3/ (400 4/)	178	100 4/	500 4/	2,413
Total	15,464	--	6,420	2,035	756	146	1,056	5,428

1/ Acreages taken from records of the Agricultural Stabilization and Conservation Service, May 1978. Note that total acres do not equal sum of rotation crops because of unknowns.

2/ HMC is high moisture (ear) corn.

3/ Land is planted to continuous potatoes or corn.

4/ Estimated.

Fertilizer, herbicide, insecticide, and fungicide use is widespread. Quantities vary from year to year depending on weather, soil moisture, cropland acreage, and insect and disease conditions. Recommendations for applications are made each year by the Maine Cooperative Extension Service (Extension). Agricultural chemicals are most widely used on seed and table stock potatoes. Grain crops receive much fewer chemicals than potatoes. Fertilizers may occasionally be applied to boost hay or pasture production, but amounts used are small compared to row crop applications.

Typically, on an acre of potatoes, 170 lbs. each of nitrogen, phosphorus and potassium are applied directly into the soil during planting. A systemic insecticide (Disyston, Temik) is also applied. A spray application of herbicide (Premerge) follows to keep down weed competition. Various insecticides (Guthion, Sevin, carbofuran, Systox, Thiodan) may be sprayed at or just after plants emerge and "repeated as necessary". Fungicides (Dithane, Polyram, Bravo, Manzate) are sprayed at weekly intervals for early and late blight. Other seasonal insect sprays are used as needed (Thiodan, Systox, Metasystox-R, Monitor, Pirimor). Finally, one or two spray applications of herbicide (Premerge, Dow general) are used to kill potato tops. About 30 percent of spraying is done aerially, the remainder is applied by tractor-pulled equipment.

About 130 pesticide applicator licenses, required for the use of restricted pesticides, have been issued in Penobscot County. There is usually at least one certified applicator per farm. Other employees or family members may be spraying or using restricted chemicals under their direct supervision.

Methods

To obtain estimates of the amounts of agricultural pesticides and fertilizers used in the District, several sources were consulted. The amount of chemicals (fertilizer for the most part) used on permanent hay and pastureland is insignificant compared to what is used on potatoes and grains. Estimates of acres of each row crop were made through the knowledge of Soil Conservation Service (SCS) personnel and ASCS. Amounts of chemicals used per acre for each crop were obtained from the 1977 Maine Farm Planning Guide. Local Extension personnel assisted in estimating amounts and kinds of chemicals applied to cropland. Some farmers were contacted to determine any great variation in the use of agricultural chemicals.

Documented problems and watersheds with potential problems were identified with the aid of the Pesticides Control Board and the Maine Department of Inland Fisheries and Wildlife. Watersheds with high average soil losses also are considered to provide potential pesticide non-point pollution. Information about existing and recommended methods for control was obtained from Extension, the Pesticide Control Board, and local farmers.

Estimated Amounts of Agricultural Chemicals Used

Estimates of farm chemicals used are of limited accuracy. Methods used to devise use recommendations and compile sales records are general and it is impossible to accurately interpolate what is actually used on each acre of cropland. Retail sales records are available only for "restricted" pesticide sales; total amounts of fertilizer and unrestricted pesticides sold are not recorded. Ideally, the amount of chemicals sold in an area should approximate the amount used on the land. However, the amount bought in one year may or may not be used during the same year. In addition, chemicals bought at one location may be used in another.

According to Extension, most farmers closely follow the recommendations specified in the Maine Planning Guide. Tables 10 through 12 estimate the amount of various chemicals used per acre for each crop, and the cropland acreage is multiplied by the recommended dosage to obtain the total amount of chemical used. Amounts of fertilizer, herbicides, fungicides, and insecticides used are calculated. Also included is the amount of fuel oil sprayed along with weedkillers.

Herbicides, fungicides, and insecticides are applied to potatoes continuously throughout the growing season. The most widely used restricted chemical is a broadleaf weed killer (Premerge, DNBP, Dow general) applied in spring to reduce competition from weeds, and in fall to kill the potato tops.

Other widely used restricted materials include insecticides such as Temik, Guthion, and Monitor. Dithane M-45, the most commonly used fungicide, is applied 8 to 10 times during a season. Despite the amounts of chemicals used, few problems related to use of this quantity of agricultural chemicals have been recorded recently. According to the Department of Inland Fisheries and Wildlife no reports of fishkills have been received. Likewise, the number of complaints brought to the Pesticides Control Board has decreased significantly in recent years. Most complaints concern spray drift during aerial application. Proper handling of most pesticides used today may account for fewer complaints. Strict laws and penalties are probably partly responsible for fewer reports of fishkills.

Estimated Amounts of Agricultural Chemicals Reaching Area Waterways

Agricultural chemicals are transported by surface runoff, soil erosion, and aerial spray. Most fertilizer chemicals are soluble and amounts reaching area waterways are due to surface runoff. On the other hand, some pesticides reach waterways through erosion, sedimentation, and poor handling methods. The actual amount of chemicals in runoff and sediment is difficult to estimate without measurements. However, some estimates have been made in the literature, and these results, methods used, and other factors influencing chemicals reaching waterways are discussed later.

TABLE 10 - ESTIMATED AMOUNTS OF FARM CHEMICALS USED PER ACRE OF OATS*
(756 acres grown in rotation with potatoes)

Chemical	Oats acreage treated (percent)	Applications (number)	Quantity recommended per acre	Total** used
Fertilizer				
Nitrogen	100	1	30 lbs.	11 tons
Phosphorus	100	1	60 lbs.	22 tons
Potassium	100	1	30 lbs.	11 tons
Lime	100	1	.5 tons	378 tons
Pesticides				
2,4-D (H)	100	1	.125 gal.	95 gal.
Systox VI (I)	75	1	.031 gal.	18 gal.

(H) Herbicide
(I) Insecticide

* 1977 Maine Farm Planning Guide
** Figures rounded to nearest half ton or gallon

Note: Some herbicides are used as part of the cultivation plan for oats, beans and rye grown alone or in other rotations. (2,4-D with oats; EPTC or pre-emergence applications on dry beans) but in general the data on this is indeterminate).

TABLE 11 - ESTIMATED AMOUNTS OF FARM CHEMICALS USED PER ACRE ON POTATOES (3,416 acres planted)*

Chemical	Potato acreage treated (percent)	Applications (number)	Quantity used per acre	Total used
Fertilizer				
Nitrogen	100	1	140 lbs.**	239 tons
Phosphorus	100	1	170 lbs.	290 tons
Potassium	100	1	170 lbs.	290 tons
Lime	25	1	.25 tons	213 tons
Pesticides				
Premerge (H)	100	1	.750 gal.	2,562 gal.
Disyston 15 G (I) (Temik)	90	1	10 lbs.	15 tons
Dithane M-45 (F) Difolatan, Polyram, Bravo, Manzate-200, Manzate-D	90	8	1.5 lbs.	18.4 tons
Guthion (I)	25	1	.2 gal.	171 gal.
Systox VI (I)	50	2	.063 gal.	215 gal.
Monitor (Pirimor) (I)	20	2	.094 gal.	128 gal.
Dow general mixture (I)	100	2	.5 gal.	1,708 gal.
Fuel Oil (with Premerge and Dow general)	100	2	5 gal.	17,080 gal.

(H) Herbicide (I) Insecticide (F) Fungicide

* 1977 Maine Farm Planning Guide

** The nitrogen rate was adjusted since most potatoes grown in Penobscot County are used for chips.

TABLE 12 - ESTIMATED AMOUNTS OF FARM CHEMICALS USED PER ACRE OF CORN*
(9,033 acres of corn planted)

Chemical	Corn acreage treated (percent)	Applications (number)	Quantity used per acre	Total used
Fertilizer				
Nitrogen	80	1	150 lbs.	542 tons
Phosphorus	100	1	120 lbs.	542 tons
Potassium	100	1	120 lbs.	542 tons
Lime	100	1	0.5 tons	4,517 tons
Herbicides				
Spray Program I - corn rotations				
Atrazine	50	1	2.5 lbs.	5.6 tons
Spray Program II - corn/potato rotations				
Bladex	25	1	0.5 gal.	1,129 gal.
Spray Program III - corn rotations				
Atrazine	25	1	1 lb.	1.1 ton
Lasso	25	1	0.5 gal	1,129 gal.

* 1977 Maine Farm Planning Guide

Note: The kinds and amounts of chemicals used depends on the crop rotation. Atrazine (2.5 lbs.) and Bladex (0.5 gal.) are used as separate and complete spray programs. Atrazine (1 lb.) and Lasso (0.5 gal.) are used together for a complete herbicide control program.

The St. John River Basin Water Quality Management Plan estimates that an average of .68 pounds of biocides enter local watercourses from each acre of potatoes.* In the Cropland Soil Erosion Appraisal it is estimated that 15 percent of the eroded soil actually reaches surface waters. Another study estimates the concentration of major fertilizer nutrients in sediments as 0.1 percent nitrogen, 0.08 percent phosphorus, and 1.25 percent potassium.** Using these figures, estimates of the amount of chemicals reaching waterways could be made.

Nutrient losses in runoff were found to range from .03 to 3.0 pounds of nitrogen per acre per year and .01 to .72 pounds of phosphorus per acre per year in a study of surface runoff from cultivated fields and permanent hay and pasture in the Upper Great Plains Area.*** Pesticide concentrations were very low, with most samples below detectable limits.

Results of studies are very site specific; many variables will influence the results. On-site sampling of runoff is an accurate way to measure chemicals reaching waterways but most chemical water pollution, like sediment pollution, is storm-related and studies must be carried out over many years to provide a complete picture.

The amount of pesticides reaching watercourses depends on residual concentrations of pesticides in ground water or attached to soil particles. Many pesticides used today will degrade into less harmful compounds within a week to a month. Biomagnification, which occurs with persistent chlorinated hydrocarbon compounds such as DDT, is not as much a threat with chemicals used today. Even though residual effects are less, short-term toxicity is more serious. Today's chemicals are more dangerous to handle and more toxic if they do reach aquatic ecosystems before breaking down. However, little research has been done on the effect of biomagnification or biodegradation of many chemicals used today. See Tables 13 and 14 for persistence of chemicals used in northern Maine.

Further research is needed to accurately estimate the amount of agricultural chemicals reaching area waterways. The effects of agricultural chemicals on ground water may be shown in a study proposed for northern Maine. The lack of evidence regarding the harmful effects of farm chemicals may indicate that insignificant amounts are reaching water resources, or that effects of present chemical use have not been discovered.

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* Northern Maine Regional Planning Commission, 1976.

** U. S. Environmental Protection Agency, 1973.

*** Dornbush, J. N., et al., 1974.

TABLE 13 - CHEMICAL WEED CONTROL IN POTATOES

Name*	Applications (number)	Mode of travel	Persistence in soil1/	Fish Toxicity2/ LC_{50} (mg/l)	Rat Toxicity2/ LD_{50} (mg/kg)
Dinoseb amine (Premerge, Sinox PE)	1-2	Sediment/water	15-30 days	.4	40
Dalapon (Dowpon M)	1	Water	2 weeks- 2 months	7,100	3,860
Paraquat EC	1	Sediment	7,500 days (inactive upon contact with exchange site)	400	150
Dow general (Sinox General)	1-2	Sediment	Short residual	highly	highly
Chlorbromuron Maloran, Bromex	1	Sediment/water	Half life is 30-120 days	.56	2,150
EPTC (Eptam)	1	Sediment/water	30 days	19.0	1,631
Alachlor (Lasso)	1	Sediment/water	40-70 days	2.3	unknown
Linuron (Lorox)	1	Sediment	120 days	16.0	15,001
Metribuzin (Sencor or Lexone)	1	Water	150-200 days	7,100	unknown
Trifluralin (Treflan 4EC)	1	Sediment	6 months	.1	5,000

1/ Variable depending on amount used; figures given are for normal use.

2/ Fish/Rat Toxicity is in terms of the lethal concentration of 50 percent of the test animals (LC_{50} or LD_{50}) in milligrams per liter or kilogram.

Sources: University of Maine Cooperative Extension Service, 1977. New England Chemical Weed Control for Commercial Potato Production. Agricultural Research Service, 1975. Control of Water Pollution from Cropland. Northeastern Regional Pesticide Coordinators, 1972. Pesticide Information Manual.

* Five gallons of fuel oil used per acre with most weedkillers to break down waxy layers of leaf.

TABLE 14 - INSECTICIDE-FUNGICIDE SPRAY RECOMMENDATIONS

Name	Applications (number)	Mode of travel	Persistence in soil1/	Fish Toxicity2/ LC_{50} (mg/l)	Rat Toxicity2/ LD_{50} (mg/kg)
Insecticide					
Disulfoton (Di-Syston 156)	1	Sediment	40-180 days	.040	highly toxic
Phorate (Thimet 10G)	1	Sediment/water	2 weeks-60 days	.0055	highly toxic
Aldicarb (Temik 15G)	1	Water	half life of 2-4 weeks	high	extreme
Azinphos-methyl (Guthion)	As necessary	Sediment	5 months	.010	highly
Carbaryl (Sevin)	As necessary	Sediment/water	3 weeks	1.0	slight
Carbofuran (Furadan 4F)	As necessary	Water	1-6 months	.21	extreme
Endosulfan (Thiodan)	As necessary	Sediment	season	.001	high
Imidan	As necessary	Sediment	short	.03	moderate
Demeton (Systox)	As needed	Water	one season	.081	highly
Oxydemeton-methyl (Metasystox)	10-14 day intervals as needed	Water	3 weeks	4.0	moderately
Methamidophos (Monitor)	As needed	—	—	—	—

TABLE 14 (cont.)

Name	Applications (number)	Mode of travel	Persistence in soil 1/	Fish Toxicity 2/ LC_{50} (mg/1)	Rat Toxicity 2/ LD_{50} (mg/kg)
Pirimicarb (Pirimor 50 W)	As needed				
Parathion	As needed	Sediment	1 week	.047	highly toxic
Methomyl (Lannate)	As needed	Unknown	Short (1 week)	.9	highly toxic
Malathion		Water	1 week	.019	slightly
Phosdrin		Water	short	.017	highly
Fungicide					
Maneb (Dithane M-22, Manzate D)	Weekly (mid-season)	Unknown	1-2 weeks	moderate	almost none
Mancozeb (Dithane M-45, Manzate 200)	Weekly		Rapid degradation, no persistence	unknown	unknown
Difolatan	Weekly	Unknown	7-10 days on plant surfaces	slightly	slightly
Polyram	Weekly	Unknown	short	slightly	none
Chlorothalonil (Bravo 6F)	Weekly		7-10 days on plant surface	moderately	slightly

1/ Variable depending on amount used; figures given are for normal use.

2/ Fish/Rat Toxicity is in terms of the lethal concentration of half of the test animals (LC_{50} or LD_{50}) in milligrams per liter or kilogram.

Sources: University of Maine Cooperative Extension Service, 1977. New England Chemical Weed Control for Commercial Potato Production. Agricultural Research Service, 1975. Control of Water Pollution from Cropland.

Watersheds with Potential for Non-Point Problems

Watersheds most likely to have water quality problems due to use of agricultural chemicals on cropland can be identified by reviewing the attached maps. Soil loss is discussed town-by-town in the Cropland Soil Erosion Appraisal. Soil loss maps were reviewed by watersheds draining intensively farmed areas with high average soil losses. It is assumed that non-point pollution by agricultural chemicals is related to soil loss, as carried in runoff water or attached to soil particles. Non-point pollution of ground water is not accounted for this way. However, as sandy, gravelly flood plain sites usually are water recharge areas, misuse of farm chemicals in such areas near larger rivers and streams could contribute to ground water pollution.

The two most likely watersheds to have water quality problems due to agriculture are the Sebasticook River and Kenduskeag Stream systems which drain into the Kennebec and Penobscot Rivers, respectively. Sebasticook Lake is of particular concern because its water quality is known to be poor. However, the amount of farm chemicals reaching surface waters of the Kenduskeag is much greater because the rate of soil erosion is much higher in this drainage. Pushaw Lake watershed includes less agricultural land, but because of its highly eutrophic condition, continued good land management on farms is important.

Methods for Control

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), passed in 1947, required federal registration of pesticides shipped across State lines and made it unlawful to sell in interstate commerce pesticides or substances that were misbranded or adulterated. Pesticides produced and used within the same State were not controlled and there were no regulations concerning use.

In 1972 FIFRA was amended to regulate all pesticides, providing stronger enforcement and making pesticide misuse unlawful. Two key provisions require that: 1) all pesticide products be classified for "general" or "restricted" use, and 2) "restricted" use pesticides be used only by, or under supervision of, certified applicators.

General use pesticides are those that "will not ordinarily cause unreasonable adverse effects on the user or on the environment when used in accordance with their label instructions." Restricted use pesticides "may cause adverse effects on the environment or the applicator unless applied by competent persons who have shown their ability to use these products safely and effectively."

FIFRA provides for two types of certified applicators, commercial and private. A private applicator uses or supervises use of restricted pesticides on property owned by him or his employer strictly for producing agricultural commodities. Commercial applicators include some government employees, persons who apply pesticides for hire, or supervise use of restricted pesticides on any property other than as provided in the definition of private applicator. Maine limited and restricted use pesticides are shown in Table 15.

The federal Environmental Protection Agency (EPA) is responsible for the FIFRA. States are responsible for certification of applicators. State certification plans must be reviewed and approved by EPA which has set up requirements for commercial and private applicator certification.

<u>Synopsis of Maine Pesticide Use Law</u>

The Maine Department of Agriculture administers pesticide control regulations. The Division of Inspection is responsible for enforcement of State pesticide registration and quality control under the Maine Pesticide Control Act of 1975. Every pesticide distributed in the State must be registered with the Department of Agriculture. Registration is a tool for determining if pesticides meet labeling requirements and do the job intended while protecting health and environment.

The Board of Pesticides Control was created in 1965 to regulate pesticide use in Maine. The Board includes the heads of eight State departments: Agriculture, Conservation, Inland Fisheries and Wildlife, Marine Resources, Human Services, Transportation, Environmental Protection, and Public Utilities.

One important Board responsibility is to certify and license those who use and sell pesticides. All commercial applicators must be examined and licensed by the Board. Since October 1976 all private applicators, such as farmers, who wish to purchase or use pesticides which EPA classifies as "restricted" must be certified by the Board, either by examination or by attending an approved training course. The Maine law requires that dealers of restricted-use pesticides also be licensed.

Certificates and licenses issued by the Board can be suspended or revoked for various reasons, including using, distributing, or storing pesticides in a faulty, careless, or negligent way; filing false or fraudulent reports; violating the provisions of State or federal pesticide laws; and using chemicals contrary to label directions.

Provisions in the law require a permit before a pesticide is applied to public waters and authorize the Board of Pesticides Control to designate critical areas where pesticide use is prohibited, due to environmental or health hazards. The law requires dealers and commercial

applicators to maintain records and submit reports of their activities. Agents of the Board can enter premises for inspection and sampling. Enforcement can be carried out by personnel of any member agency of the Board. For example, wardens of the Department of Inland Fisheries and Wildlife have been designated to enforce provisions of the pesticide use law dealing with environmental concerns.

Penalties for violation of the law are severe with possible first-offense fines of up to $500. This is the minimum for subsequent offenses, and each day a person operates in violation is considered a separate offense.

Pesticide applicator categories and competency standards required for certification and licensing have been established. Provisions for state and federal agencies to cooperate in publishing information and to make rules and regulations are included in the law.

Enforcement of regulations in the field is carried out by game wardens who make sure that pesticides are handled properly. However, preventive measures are difficult to enforce. Wardens are trouble-shooters for problems as they occur. The Department of Environmental Protection also has jurisdiction over improper pesticide use if a water body is contaminated.

Research and Education

The Cooperative Extension Service works with the Pesticides Control Board to carry out a program of education and research in pesticide use. Guidelines on pesticide use for specific crops are published annually, and workshops are held each year to inform farmers of new materials, methods, and regulations and proper pesticide use.

One research project is showing that unrinsed pesticide containers disposed of by burial, as recommended by the State, can cause pollution of ground water. It is thought that properly rinsed containers would not cause ground water contamination.

The Integrated Pest Management Program is designed to minimize the number of pesticide applications, while maintaining high levels of production. This is changing potato growers' concept of a weekly spray program to a program based on need as determined by environmental monitoring and insect population evaluation. The three projects in this program include: flight forecasting, which saved cooperators 4.7 sprays in 1977; aphid monitoring and control, which saved cooperators 3 sprays in 1977; and Canada plum eradication, which destroys an aphid alternate host plant.

This Integrated Pest Management Program has been active since 1974. It has become a total industry effort involving growers, grower organizations, industry organizations, commercial establishments, and town officials. The program offers promise for improved methods of insect and disease control with minimum use of pesticides.

Trends in Chemical Use

Increased participation of growers in the Integrated Pest Management Program (22 in 1974 to 63 in 1976), indicates a definite interest in more controlled use of agricultural chemicals. Adverse environmental effects are undesirable and chemical costs are significant, so growers are open to suggestions about efficiency. However, maximum production and economics will continue to govern farm management practices. Hopefully, chemical use can be minimized through preventive and management practices.

In the last 10 years there has been a changeover from long-lasting hydrocarbon pesticides to more toxic but short-lived pesticides with fewer or no known residual effects. This, together with better pesticide management practices and use, has resulted in few fishkill reports and pesticide use complaints. This may indicate that total environmental effects are being reduced.

Future Needs and Recommendations

The major problem related to use of agricultural chemicals is that of used pesticide container disposal. Complaints of drifting pesticide sprays have reduced in frequency, likely as a result of the pesticide licensing/education program. The recommended method for disposal of pesticide containers is a "triple rinse" prior to burial in landfill with suitable soils and at least 18 inches of cover. Containers should be crushed, so they cannot be reused for any purpose. Included in this report are State recommendations for pesticide container disposal (Appendix).

Some States recommend certain containers be burned when the label does not indicate otherwise. Extremely hazardous conditions can result when pesticide containers are burned and air quality regulations make this method illegal. Locally, arrangements could be made with municipal landfill operators so special areas could be used for pesticide container disposal.

Presently, pesticide containers are often disposed of in on-farm dumps at rock piles or near surface water sources where spray equipment is filled. Both locations, especially those near water sources or "spray holes" are obvious sources of pollution. Piles of containers are often burned at the end of a season. This reduces hazards of water contamination, but is illegal and hazardous to health.

A proper institutional arrangement for chemical waste and container disposal is needed. Unfortunately, effects of improper container disposal have not been documented nor have they provided cause for many complaints. Further investigation is needed before the cost of any solution can be justified. Several possible solutions are described below. For more detail, see "Summary of Interim Guidelines for Disposal of Surplus or Waste Pesticides and Pesticide Containers" (1970) by the Working Group on Pesticides.

Emphasis must be made of the fact that pesticides should be purchased only in the amount needed during one season. An entire preparation made for any one application should be used for that application. This prevents risks of storage or disposal of unused materials.

Smaller containers should be burned or buried after being rinsed and crushed according to manufacturers' instructions on the label. Many of the larger containers (30 and 55 gallon drums) can be reused although at present no local dealers have facilities for such recycling. Further research is needed to evaluate feasibility of local use of such a facility.

Incineration under carefully controlled time and temperature conditions is a good method for disposing of large amounts of toxic waste and containers. Harmless carbon dioxide and water should result from proper, complete combustion under high temperatures in special facilities. This method is still being researched. An incinerator equipped with scrubbers to eliminate escape of hazardous gas is feasible for non-industrial amounts of pesticides. A collection program is an essential part of the whole waste pesticide storage and disposal problem. Motivation for continued participation of pesticide users in a collection program can be maintained by well-publicized collection drives, use of special reminder labels, and participation of local advisory committees. Legislation may be required.

Potential solutions, still in experimental stages, include detoxification and use of dissolving containers. Detoxification involves use of other chemicals to render toxic pesticides harmless. Dissolving biodegradable containers are put into the sprayer along with the chemical and spread onto the land.

Further measure of water contamination by improper pesticide disposal waste is needed immediately, in light of the amounts used. Combined chemical effects and products of decomposition must be closely examined. The effects of the use of fertilizer and fuel oil (mixed with active ingredients) also warrant investigation. The ground water study proposed for northern Maine may shed some light on the magnitude of pesticide contamination.

The new requirements of the Safe Drinking Water Act will provide for routine testing for some hazardous chemicals in public water supplies. These tests may shed light on the size and extent of the proper solution to the problem of agricultural chemical contamination of water resources.

Potential pollution from pesticides and nutrients which are water soluble or adhere to sediment can be reduced by soil and water conservation practices.

Contour plowing, etc., reduces water runoff and holds nutrients and some pesticides on the land where they can be used by plants or changed to less harmful chemicals by biological process.

Improved soil structure holds water and provides more organic matter to hold nutrients.

Reduced erosion lessens the amount of nutrients (primarily phosphorus) and some pesticides destined for surface waters.

Winter cover crops tie up nitrogen through the fall and winter. Spring plowing releases this nitrogen into the soil to aid in crop production, as well as improve soil structure and reduce erosion.

A complete system of conservation practices is essential on all fields in a watershed to significantly reduce pollution. This could include a manmade pond or settling basin in which farm runoff can be diverted before being discharged to public streams and lakes to assist in final treatment of agricultural runoff.

Conservation planning, technical assistance, economic assistance, legislation, education, and research must be put together to help farmers stay in business, maintain or increase productivity, and contribute to improved water quality.

TABLE 15 - MAINE LIMITED-USE AND RESTRICTED-USE PESTICIDES LIST - MAY 1976

LIMITED - To be sold only by licensed dealerships to certified pesticide applicators, and to be used only by permit from Board of Pesticide Control, issued under conditions of Special Regulations, Section 4.

Aldrin
DDD
DDT
Dieldrin
Endrin
Heptachlor
Sodium Monofluoroacetate (Compound 1080)
Thallium salts
Toxaphene

RESTRICTED - To be sold only by licensed dealerships to certified pesticide applicators.

Acrylonitrile
Aldicarb (Temik)
Arsenic compounds (above 2 percent concentration)
Avitrol
Azodrin
Baytex
Benzene Hexachloride
Bidrin
Cadmium compounds
Carbofuran (Furadan, above 10 percent)
Carbon Disulfide
Carbon Tetrachloride (as a pesticide)
Carbophenothion (Trithion)
Chlorfenvinphos (Compound 4072)
Chloropicrin
Cyanides
Cycloheximide (Acti-dione, above 1.3 percent)
*Dasanit (fensulfothion, above 10 percent)
Demeton (Systox)
*Di-Syston (Disulfoton, above 1 percent)
*DNBP (Dinoseb, Dow General, Premerge, Sinox General, Chemox General)
DNOC (Sinox, above 2 percent)
DNOCHP (DN-111)
Dyfonate (above 15 percent)

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*All granular formulations unrestricted, regardless of concentration.

TABLE 15 (cont.)

Endothall
EPN
Ethion (above 40 percent)
Ethyl Guthion
Ethylene Dibromide
Formetanate Hydrochloride (Carzol)
Guthion
Lindane (above 20 percent)
Mercury compounds
*Metasystox-R (above 40 percent)
Methidathion (Supracide)
Methomyl (Lannate)
Methyl Bromide
Methyl Parathion
Monitor
Nicotine alkaloid
Nicotine salts (above 40 percent expressed as alk.)
Oxamyl (Vydate)
Paraquat (above 0.2 percent)
Parathion
Phorate (Thimet)
Phosdrin (above 2 percent)
Phosphamidon
Phosphorus (white and yellow)
Phostoxin
Schradan
Selenium compounds
Strobane
Strychnine
Sulfotepp
Sulfuryl Fluoride
TEPP
Thiodan (Endosulfan, above 10 percent)
Vapona (Dichlorvos, DDVP, above 25 percent)
Warbex (Famphur, above 1 percent)
Zinophos (above 2 percent)

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* All granular formulations unrestricted, regardless of concentration.

APPENDIX

Universal Soil Loss Equation (USLE)

The Universal Soil Loss Equation (USLE) computes long-term average annual soil losses for specific combinations of land conditions and use. It was developed about 20 years ago by the U.S. Department of Agriculture's Science and Education Administration - Federal Research (SEA-FR) (formerly Agricultural Research Service), and was designed and field tested for the following uses:

1) Predicting average annual soil movement from a given field slope under specified land use and management conditions.

2) Guiding the selection of conservation practices for specific sites.

3) Estimating the reduction in soil loss attainable from various changes that a farmer might make in his cropping system or cultural practices.

4) Determining how much more intensively a given field could be safely cropped if contoured, terraced, or stripcropped.

5) Determining the maximum slope length on which cropping and management systems can be tolerated in a field.

6) Providing local soil loss data to use when discussing erosion control needs and conservation plans with farmers or contractors.

7) Estimating soil losses from construction, rangeland, woodland, and recreational areas.

The prediction accuracy of the equation has been checked and found to be statistically reliable provided the equation has been used properly. The USLE predicts <u>only</u> sheet and rill erosion.

The equation is: A = RKLSCP

A = Average soil loss in tons per acre per unit of time
R = Rainfall and runoff-erosivity factor
K = Soil-erodibility factor
L = Slope-length factor
S = Slope-gradient factor
C = Cropping-management factor
P = Erosion-control practice factor

The following is a brief description of each factor and how it was determined and used for the SNAP appraisal.

R - Rainfall and runoff-erosivity factor - is a measure of the erosive forces of rainfall and runoff. The energy of moving water detaches and transports soil particles. The energy-intensity (EI) parameter is the product of two rainstorm characteristics: total kinetic energy of a storm times the maximum 30-minute intensity. The product reflects the combined potential of raindrop impact and turbulence of runoff to transport dislodged soil particles. Soil losses are linearly proportional to the number of EI units. EI values from all storms within a year are added to obtain an annual rainfall and runoff-erosivity factor (R) for a given location. This factor has been evaluated for many years and the values are reliable long-term regional averages. In this study an R value of 100 was used in all counties except Aroostook, which used 75.

K - Soil erodibility factor - reflects the inherent erodibility of a particular soil. When rainfall with a known erosive potential falls on a standard research plot (soil in cultivated continuous fallow, on a 9 percent slope 72.6 feet long) of a known soil type, the eroded soil leaving the plot indicates the erodibility of that soil. The capability of a soil surface to resist erosion is a function of the soil's physical and chemical properties, such as texture, organic matter content, soil structure, permeability, and surface stoniness. K can be computed as a function of these properties or developed experimentally through research. Values of K used in the SNAP Appraisal ranged from 0.17 to 0.49 depending on the soil series. Soil types were determined from published, interim, or unpublished soil surveys. K values were taken from the SCS Field Office Technical Guide.

L - Slope-length factor and S - Slope-gradient factor - are dimensionless factors that adjust the soil loss estimate for effects of length, steepness, and shape of the field slope. They are combined because of their close interaction. The LS factor is the expected ratio of soil loss per unit area on a field slope to corresponding loss from the standard research plot. Doubling the length of slope increases erosion approximately 1.5 times. Doubling the steepness (percent slope) increases erosion approximately 2.5 times. Slope length is the distance from the point of origin of overland flow to the point where the slope gradient decreases enough to cause deposition or to a point where runoff enters a well defined channel. In this appraisal the average slope gradient for a field was measured with an Abney level and average length of slope was measured on aerial photographs.

C - Cropping-management factor - introduces the effects of the cropping system and management variables on soil loss. The basic soil loss is the rate at which a field would erode if it were continuously in tilled fallow. The equation's factor C indicates the percentage of this potential soil loss that would occur if the surface were partially protected by some particular combination of cover and management.

During the erosion study, judgment was needed to select the correct C value. An estimate had to be made as to what rotation was being used on each farm unit. This was often done in relation to the percentage of a farm unit that was in potatoes and other crops. For example, if one quarter of the farmland was in oats, one quarter in hay, and the remainder in potatoes, the rotation would be estimated as potatoes, potatoes, oats, and hay. Unless otherwise known, all potatoes were considered to be fall plowed, late harvested, with residue left.

P - Erosion-control practice factor - reflects the benefits of supporting practices, such as contouring, contour stripcropping, cross-slope farming, and cross-slope farming with strips. Terraces or diversions are not included because they reduce the length of slope only. P is the ratio of soil loss with the supporting practice to the soil loss with up-and-down hill cultivation. For example, contour stripcropping on gentle slopes can reduce soil loss by 75 percent. The value of any practice is reduced as slopes steepen.

Soil erosion by water is influenced by many variables. The soil loss equation isolates significant variables and expresses them as a number. When the numbers for all six variables are multiplied, the product is the amount of soil loss expressed in tons per acre per year. Soil loss was not predicted for a specific year, but rather for long-term average annual loss under specific conditions. The USLE does not estimate gully erosion.

The following example illustrates the use of the USLE:

A twenty acre field on Bangor silt loam is evaluated for soil loss. The average slope is 600 feet long and has a gradient of 6 percent. The rotation is 1 year of potatoes followed by 1 year of silage corn. The R factor for this area is 100. The combined LS factor is 1.65. Bangor soils have a K factor of .17. Potato vines are removed after harvest and the field is spring plowed resulting in an average C factor for the PC rotation of .42. The field is farmed up and down slope, therefore, the P factor is 1. Average soil loss (A) = RKLSCP, A = 100 X .17 X 1.65 X .42 X 1 or 11.8 tons per acre per year. Since it is a 20-acre field, total average annual soil loss from sheet and rill erosion is 236 tons per year.

Sediment Delivery Ratio

To determine an average sediment delivery ratio, the magnitude of the sediment yield at a given point in a watershed and the total amount of erosion must be known. The formula is DR = Y/E where Y = the sediment yield at the downstream location and E = the total (gross) erosion, which includes gully, channel, and sheet-rill erosion above that location.

The sediment delivery ratio (DR) is usually expressed as a percentage.

Rough estimates of sediment delivery can be made from the following table.*

Drainage Area (square miles)	Sediment Delivery Ratio (DR)
0.5	.33
1	.30
5	.22
10	.18
50	.12
100	.10
200	.08

---

* From Control of Water Pollution from Cropland, Volume I, Agricultural Research Service (presently the Science and Education Administration - Federal Research), 1975. Report Number ARS-H-5-1.

Study Limitations

This study was conducted in the field with the assistance of Soil and Water Conservation District Supervisors, Federal and State technicians, and farmers. Despite a sincere effort to include all cropland fields over 10 acres in size and all farms with 10 or more animal units, the inventory is not perfect. Acreage figures are approximated by using a dot grid on uncontrolled aerial photographs.

The Conservation District, with the assistance of local technicians, will update, correct, and maintain this inventory on maps in the District office.

"208"

References to "208" in this report are related to actions taken and committees formed to carry out the directives in section 208 of Public Law 92-500, the Federal Water Pollution Control Act, as amended in 1977.

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STATE OF MAINE
DEPARTMENT OF HEALTH AND WELFARE
Augusta, Maine
Telephone 207-289-2727

March 1974

Dean Fisher, M.D.
Commissioner

To: All Farmers and Custom Applicators
Subject: Disposal of Pesticides and Pesticide Containers

Several questions on pesticide disposal have recently been directed to the Public Health Laboratory. While the laboratory does not have primary responsibility for this matter, it does wish to express the thought that improper disposal can affect public health and the aim of this letter is to provide some of the answers concerning this growing problem.

The primary goal in disposing of pesticides and pesticide containers is to ensure that these materials are not allowed to contaminate ground and surface waters or the atmosphere. In performing this task, it is essential that children, unsuspecting adults, pets, livestock and wildlife are prevented from coming in contact with the chemicals.

State regulations now require persons with surplus pesticides and containers to bury them or store them in a safe place while awaiting better disposal methods. Burial in a properly operated sanitary landfill is the best alternative presently available in Maine. Decomposition of pesticides by incineration is the most desirable method but there are no facilities in this state that are capable of detoxifying most pesticides. Open-burning dumps, whether on the farm, or operated by a municipality, are definitely unacceptable due to the high risk of polluting both air and water.

Since few communities have developed suitable landfill operations, it may be necessary for an individual or a group of applicators to establish their own burial area. A proper site must be chosen with great care, and if in doubt, advice should be sought from soil scientists and other persons with knowledge of soils. An isolated area is best and it should be 500 feet distant from homes, livestock yards, wells, rivers and ponds. It should be situated so that little runoff occurs and there should be no chance for flooding. The soil should be at least six feet deep and somewhat poorly drained to prevent leaching of the pesticide.

Prior to actual burial, the containers should be perforated and crushed to allow degradation of remaining chemicals. After all materials are in the pit, they should be covered with a thin layer of lime since raising the pH in this matter helps to speed detoxification of most pesticides. The materials should finally be covered with at least eighteen inches of soil and the area marked with warning signs. A fence to prevent children and animals from entering the area would also be desirable.

Several precautions may be observed to minimize the amount of materials requiring disposal and the hazards involved in burying them. In addition, both time and money will be saved by employing the following suggestions:

1. Always read the label and follow its directions.
2. Purchase only as much pesticide as you have definite plans to use during one season.
3. Prepare only as much pesticide as needed at any one time for the control of a specific pest(s).
4. Use all the spray, dust or granules you prepare for any single application.
5. Follow the "Rinse and Drain" procedure when emptying containers holding liquid formulations.

   A. Empty container into spray tank and allow an extra thirty seconds to drain.
   B. Refill container one-quarter full with water or other carrier material to dilute remaining pesticide.
   C. Replace cap and shake or rotate container to rinse insides thoroughly.
   D. Add this rinse material to spray tank and repeat the procedure for a total of three complete rinses. This will reduce original concentration by more than 1000-fold and put the pesticide on the field where you want it.

6. Return thirty and fifty-five gallon drums to manufacturer whenever possible. Keep safely stored until shipping date.
7. Puncture, crush and bury smaller containers so they cannot be used for any other purpose. Keep safely stored until time for burial.
8. Keep all tops, lids and bungs in place on containers that have been partially used to prevent contamination.
9. Keep all pesticides properly stored to prevent damage from freezing, fire or mechanical injury.
10. Burn flammable containers of fungicides and certain herbicides if so instructed on the label. Remember, personal or crop injury may result from burning of pesticides and containers not recommended for this type of disposal.

In summary, the ultimate responsibility for pesticide safety lies with the applicator and the spray job isn't completed until the materials have been returned to storage or received proper disposal. If you have further questions requiring more specific information, I would be happy to assist in obtaining additional answers for you.

Yours truly,

/s/ Robert I. Battesse, Jr.

Robert I. Battesse, Jr.
Pesticide Project Coordinator
Public Health Laboratory

RIB/rk

SOURCE of Base Map: U.S. Geological Survey 15' and 7½' quadrangle maps (provided by Soil and Water Conservation Districts and the State Planning Office).

MAINE

SPONSORED by the Maine Soil and Water Conservation Commission and the Maine Department of Environmental Protection and the Maine State Planning Office in cooperation with the USDA Soil Conservation Service and the Statewide USDA 208 Committee.

LEGEND

ANIMAL UNITS, NON — POULTRY FARMS

10+	10 - 24	Animal Units
25+	25 - 49	Animal Units
50+	50 - 99	Animal Units
100+	100 - 199	Animal Units
200+	200 - 399	Animal Units
400+	400 - 599	Animal Units
600+	600 - 799	Animal Units
800+	800 - 999	Animal Units
1000+	1000 - 1099	Animal Units
1100+, 1200+	....	Animal Units On Larger Farms

ANIMAL UNITS, POULTRY FARMS

P10	10 - 24	Animal Units
P25	25 - 49	Animal Units
P50	50 - 99	Animal Units
P100	100 - 199	Animal Units
P200	200 - 399	Animal Units
P400	400 - 599	Animal Units
P600	600 - 799	Animal Units
P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100, P1200	....	Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

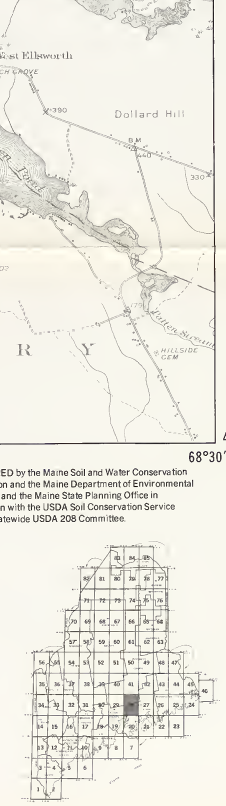
0 - 3 tons
4 - 5 tons
6 - 7 tons
8 - 10 tons
11 - 25 tons
26 + tons
Gully

△ APPROVED ANIMAL WASTE FACILITY

ACRES
100

0 1 2 3 MILES
Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT

SOURCE of Base Map: U.S. Geological Survey 15' and 7½' quadrangle maps (provided by Soil and Water Conservation Districts and the State Planning Office).

MAINE

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LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10 +	10 - 24	Animal Units
25 +	25 - 49	Animal Units
50 +	50 - 99	Animal Units
100 +	100 - 199	Animal Units
200 +	200 - 399	Animal Units
400 +	400 - 599	Animal Units
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26 + tons
Gully

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P100	100 - 199	Animal Units
P200	200 - 399	Animal Units
P400	400 - 599	Animal Units
P600	600 - 799	Animal Units
P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100, P1200	....	Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

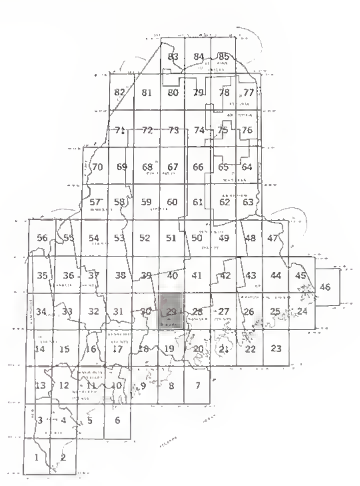
△ APPROVED ANIMAL WASTE FACILITY

25 ACRES 100

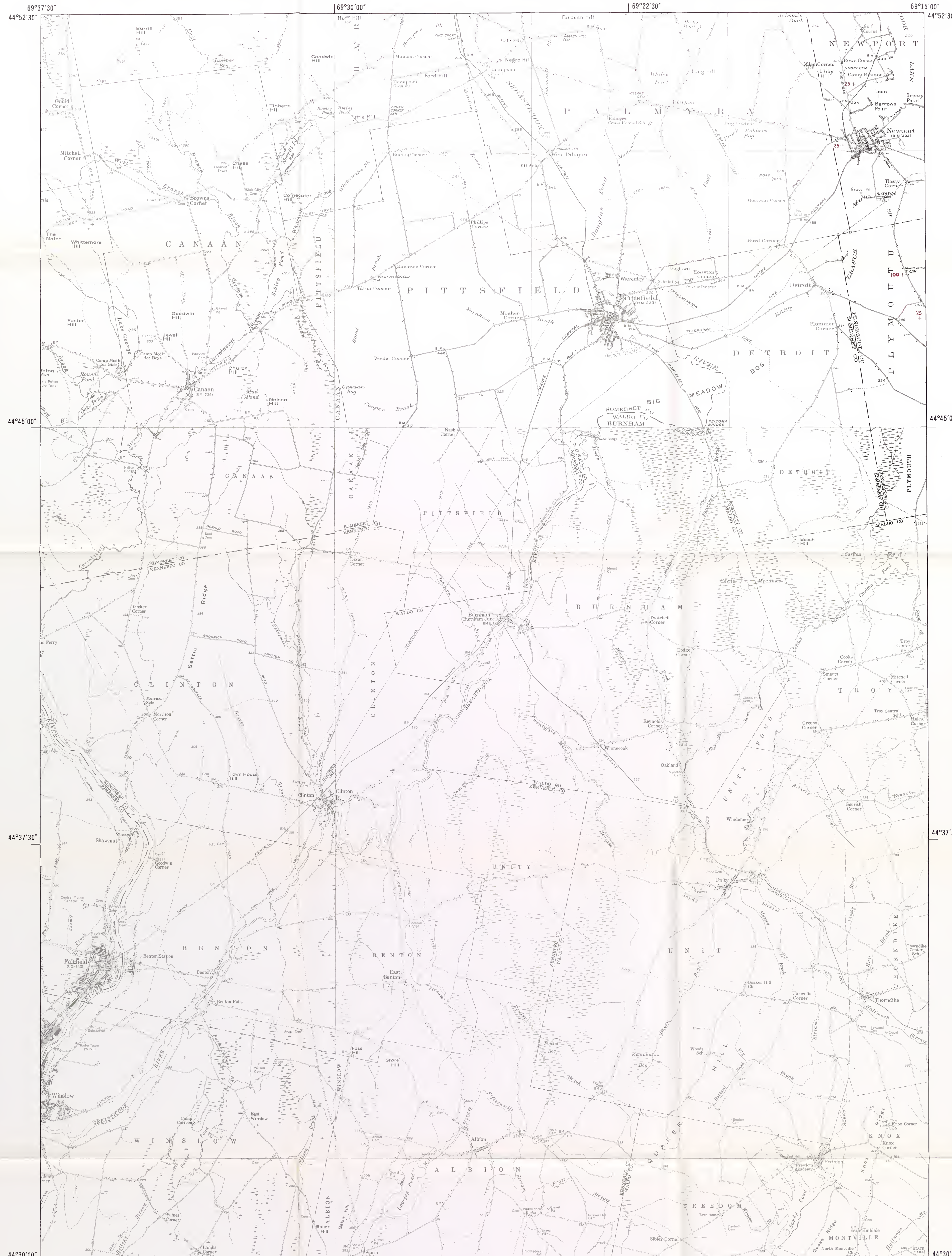
0 1 2 3 MILES

Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT



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LEGEND

ANIMAL UNITS, NON – POLTRY FARMS

10+	10 - 24	Animal Units
25+	25 - 49	Animal Units
50+	50 - 99	Animal Units
100+	100 - 199	Animal Units
200+	200 - 399	Animal Units
400+	400 - 599	Animal Units
600+	600 - 799	Animal Units
800+	800 - 999	Animal Units
1000+	1000 - 1099	Animal Units
1100+, 1200+	....	Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0 - 3 tons	8 - 10 tons
4 - 5 tons	11 - 25 tons
6 - 7 tons	26 + tons
	Gully

ANIMAL UNITS, POULTRY FARMS

P10	10 - 24	Animal Units
P25	25 - 49	Animal Units
P50	50 - 99	Animal Units
P100	100 - 199	Animal Units
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P400	400 - 599	Animal Units
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P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100, P1200	....	Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

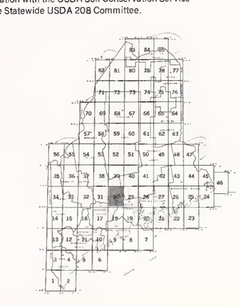
△ APPROVED ANIMAL WASTE FACILITY

31 / 25 / 100 ACRES

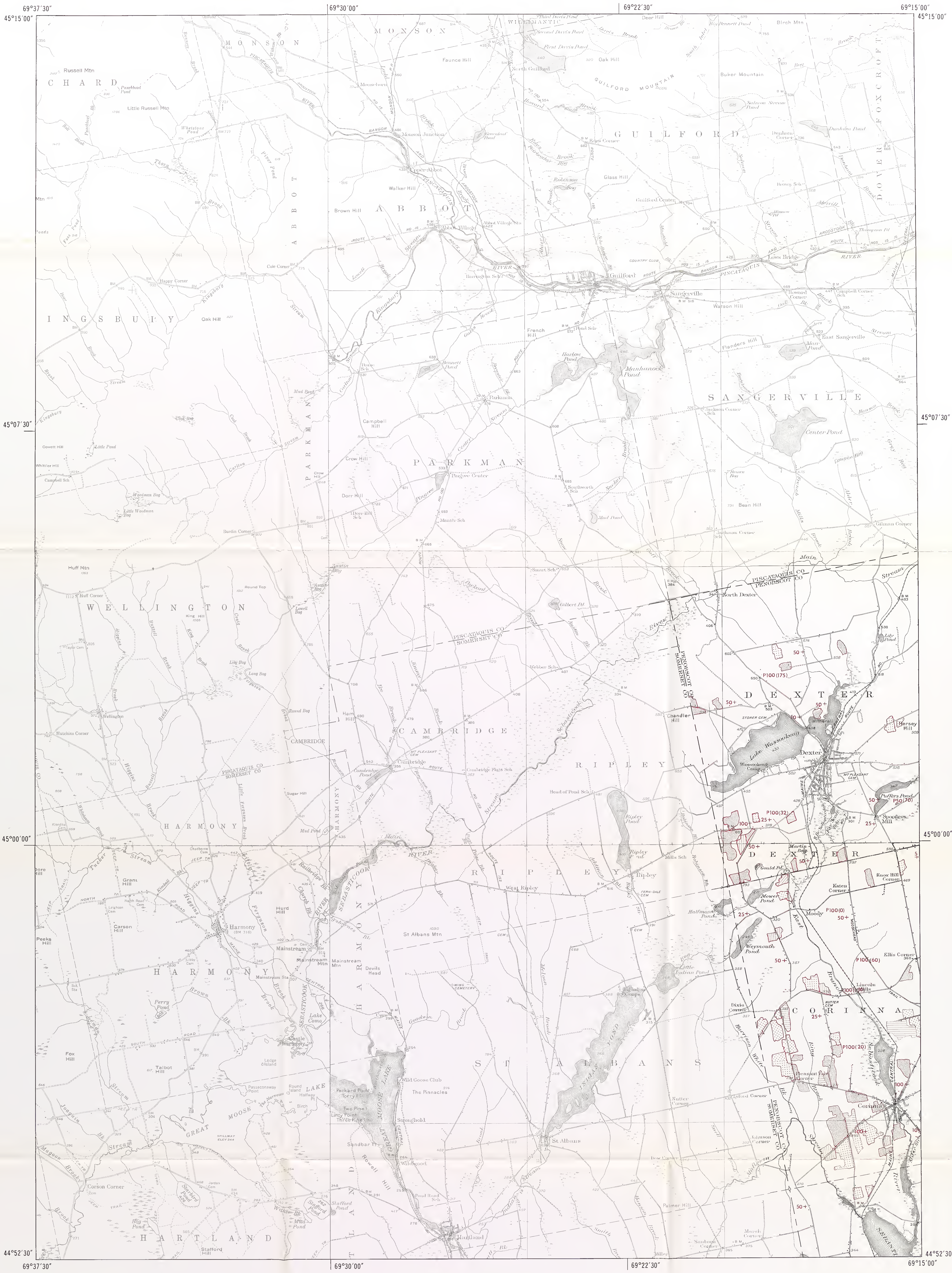
0 1 2 3 MILES

Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT



SOURCE of Base Map: U.S. Geological Survey 15′ and 7½′ quadrangle maps (provided by Soil and Water Conservation Districts and the State Planning Office).

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LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10+	10 - 24	Animal Units
25+	25 - 49	Animal Units
50+	50 - 99	Animal Units
100+	100 - 199	Animal Units
200+	200 - 399	Animal Units
400+	400 - 599	Animal Units
600+	600 - 799	Animal Units
800+	800 - 999	Animal Units
1000+	1000 - 1099	Animal Units
1100+, 1200+		Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0 - 3 tons
4 - 5 tons
6 - 7 tons
8 - 10 tons
11 - 25 tons
26 + tons
Gully

ANIMAL UNITS, POULTRY FARMS

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P100	100 - 199	Animal Units
P200	200 - 399	Animal Units
P400	400 - 599	Animal Units
P600	600 - 799	Animal Units
P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100, P1200		Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

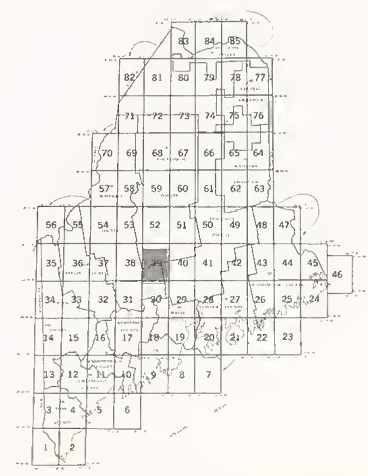
△ APPROVED ANIMAL WASTE FACILITY

5 | 25 | 100 ACRES

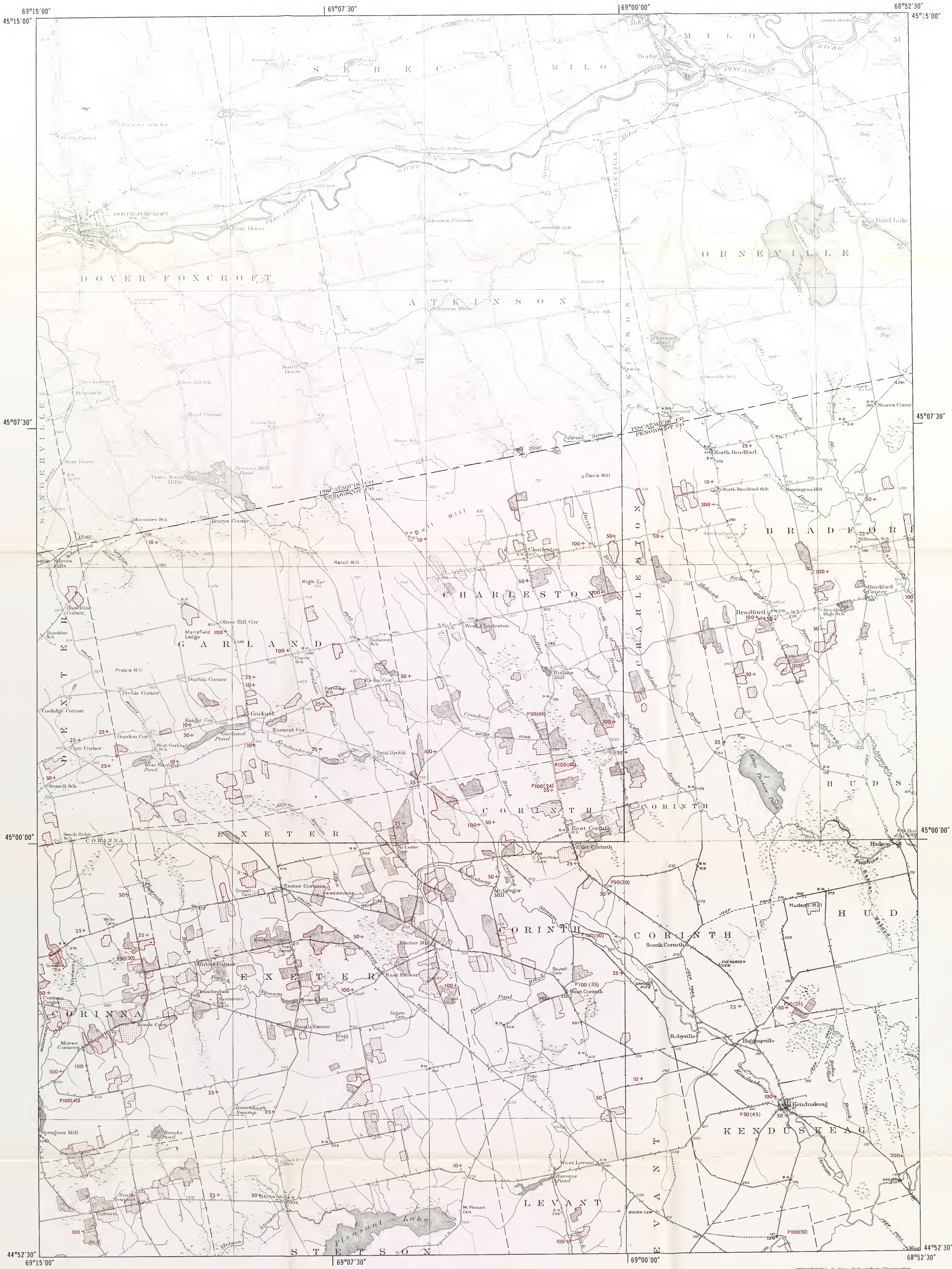
0 1 2 3 MILES

Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT



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LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10+	10 - 24	Animal Units
25+	25 - 49	Animal Units
50+	50 - 99	Animal Units
100+	100 - 199	Animal Units
200+	200 - 399	Animal Units
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AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0 - 3 tons	8 - 10 tons
4 - 5 tons	11 - 25 tons
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	Gully

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P600	600 - 799	Animal Units
P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100,	P1200	Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Oisposal

△ APPROVED ANIMAL WASTE FACILITY

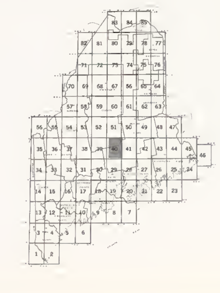
50 / 25 / 100 ACRES

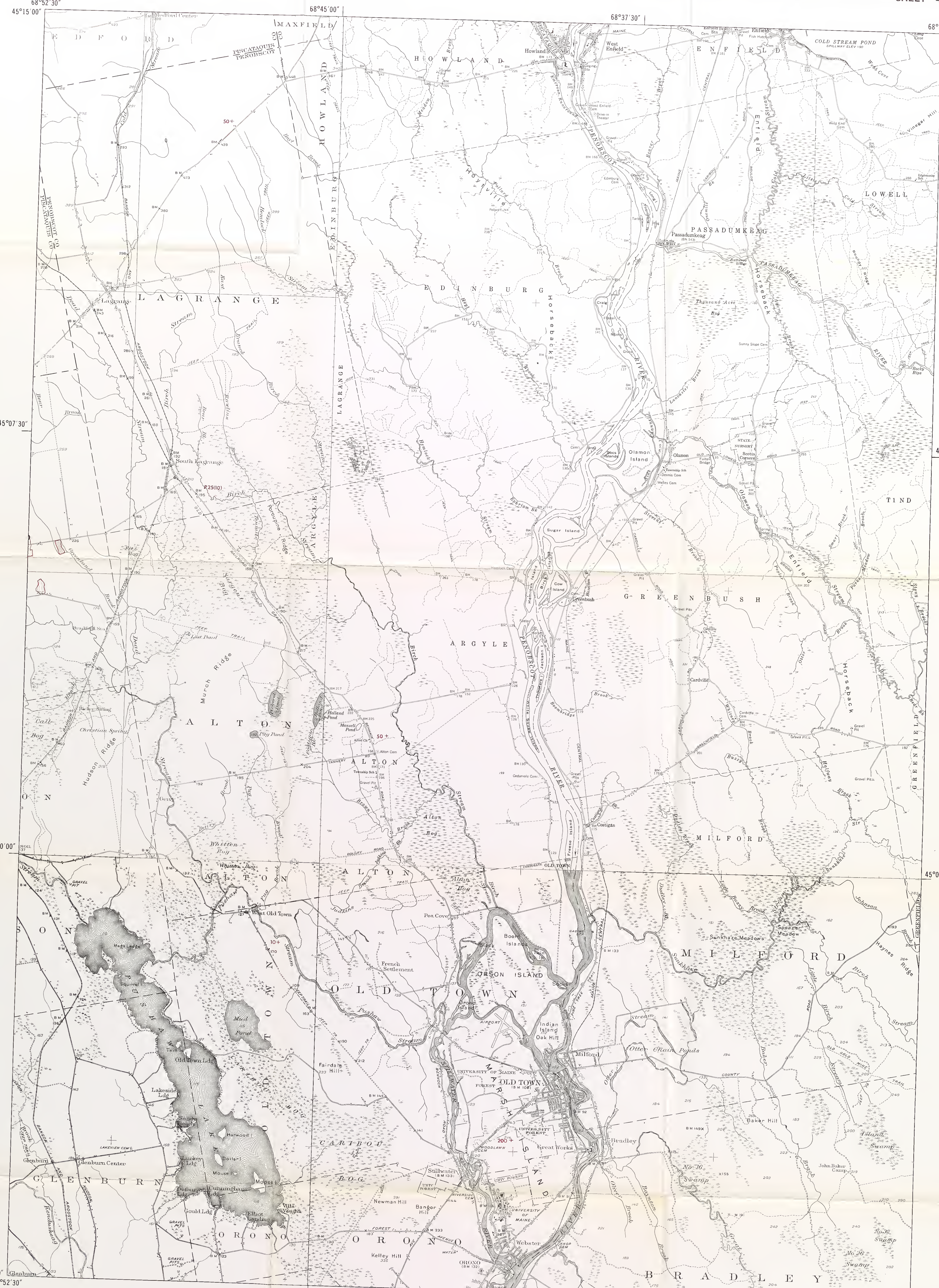
0 1 2 3 MILES

Scale 1:50 000

N

PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT





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LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10+	10 - 24	Animal Units
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50+	50 - 99	Animal Units
100+	100 - 199	Animal Units
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1000+	1000 - 1099	Animal Units
1100+, 1200+		Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0 - 3 tons
4 - 5 tons
6 - 7 tons
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26 + tons
Gully

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P800	800 - 999	Animal Units
P1000	1000 - 1099	Animal Units
P1100, P1200		Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

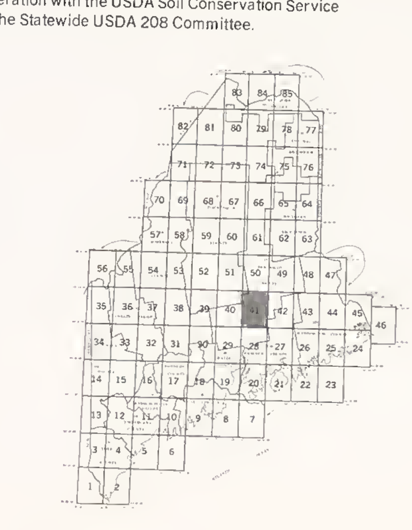
△ APPROVED ANIMAL WASTE FACILITY

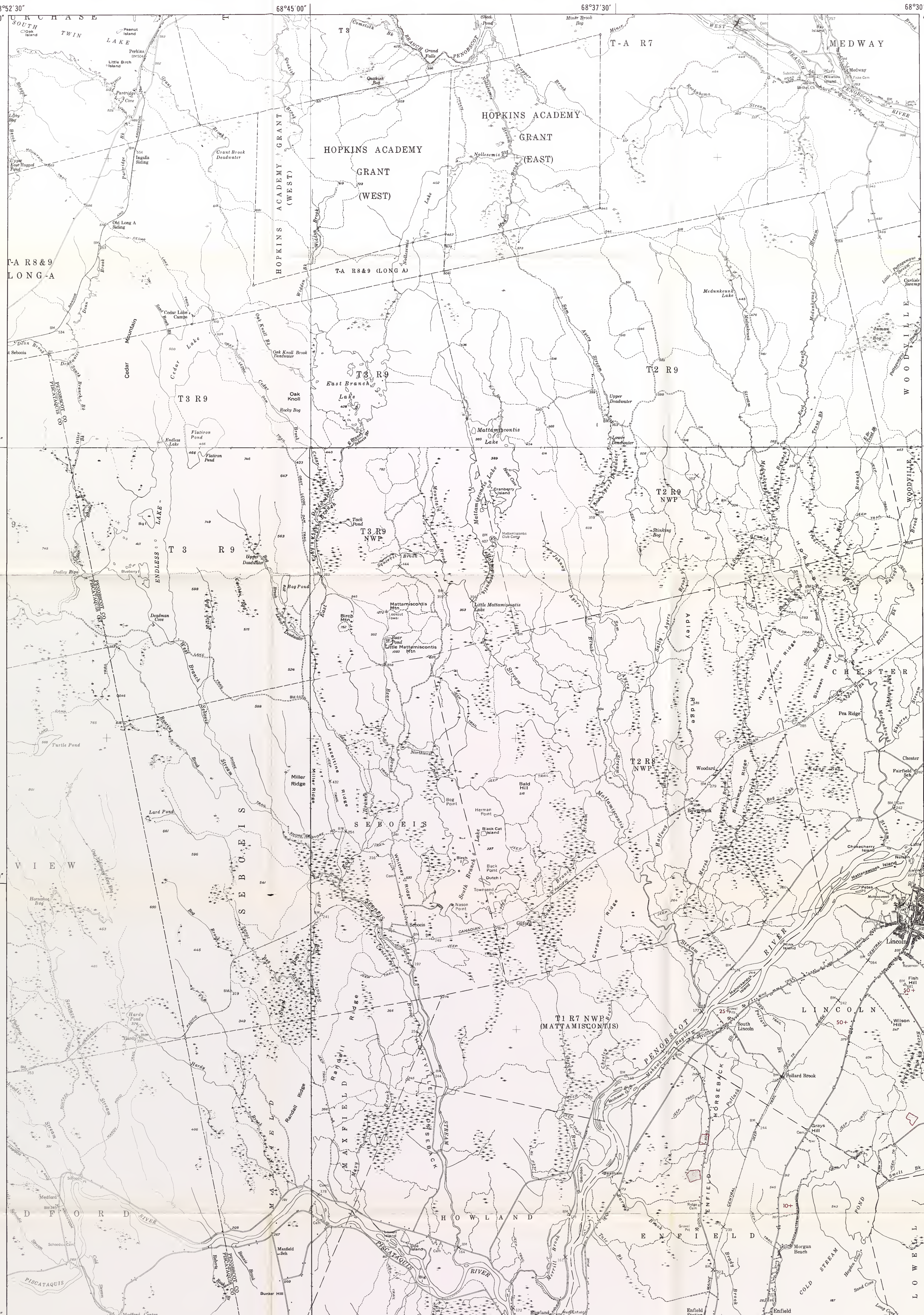
5 25 100 ACRES

0 1 2 3 MILES
Scale 1:50 000

N

PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT





MAINE

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LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

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50+	50-99	Animal Units
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200+	200-399	Animal Units
400+	400-599	Animal Units
600+	600-799	Animal Units
800+	800-999	Animal Units
1000+	1000-1099	Animal Units
1100+, 1200+		Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0-3 tons	8-10 tons
4-5 tons	11-25 tons
6-7 tons	26+ tons
	Gully

ANIMAL UNITS, POULTRY FARMS

P10	10-24	Animal Units
P25	25-49	Animal Units
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P100	100-199	Animal Units
P200	200-399	Animal Units
P400	400-599	Animal Units
P600	600-799	Animal Units
P800	800-999	Animal Units
P1000	1000-1099	Animal Units
P1100, P1200		Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

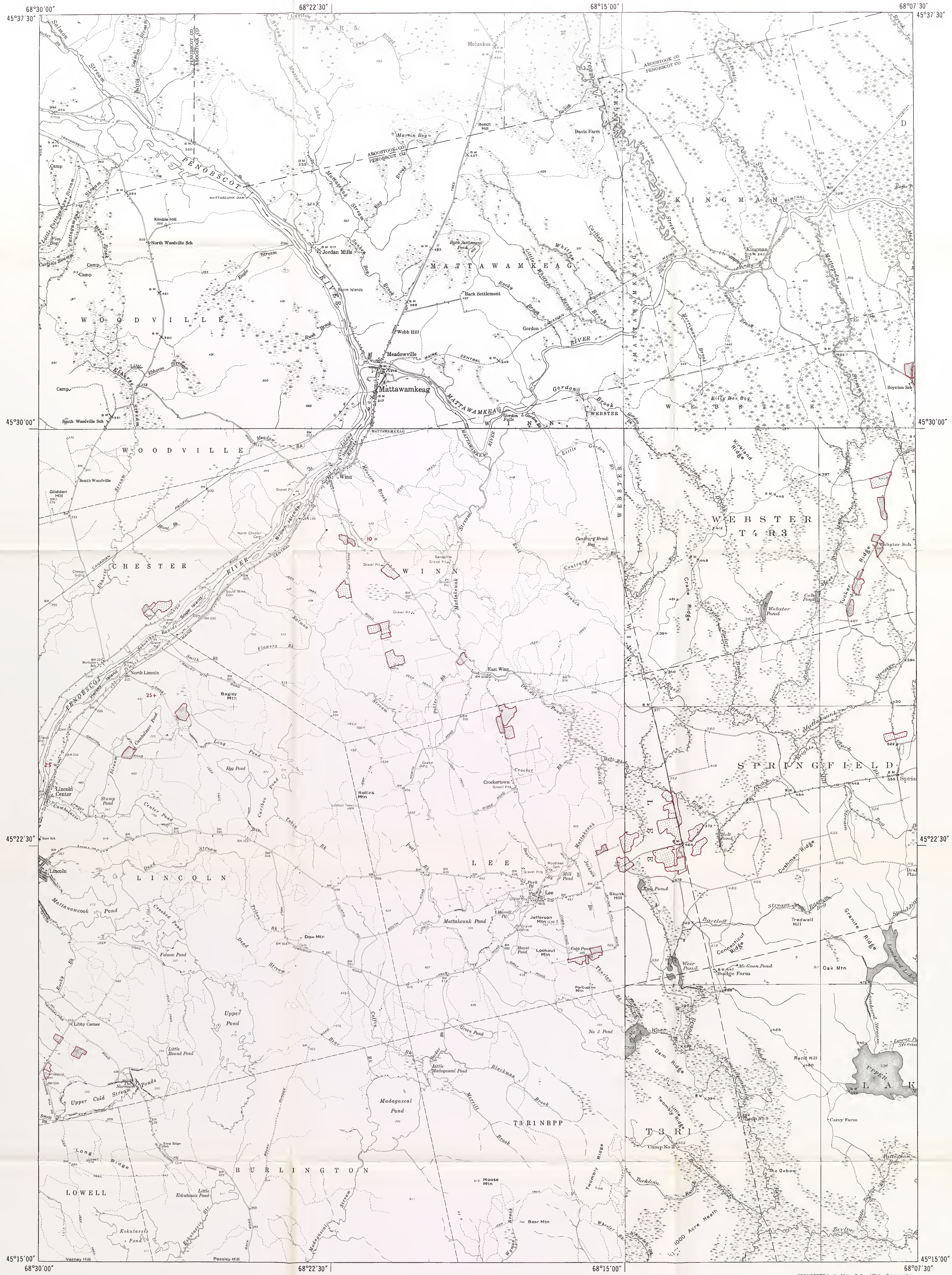
△ APPROVED ANIMAL WASTE FACILITY

50 / 25 / 100 ACRES

0 1 2 3 MILES
Scale 1:50 000

N

PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT



SOURCE of Base Map: U.S. Geological Survey 15′ and 7½′ quadrangle maps (provided by Soil and Water Conservation Districts and the State Planning Office).

MAINE

SPONSORED by the Maine Soil and Water Conservation Commission and the Maine Department of Environmental Protection and the Maine State Planning Office in cooperation with the USDA Soil Conservation Service and the Statewide USDA 208 Committee.

LEGEND

ANIMAL UNITS, NON – POULTRY FARMS

10+	10-24	Animal Units
25+	25-49	Animal Units
50+	50-99	Animal Units
100+	100-199	Animal Units
200+	200-399	Animal Units
400+	400-599	Animal Units
600+	600-799	Animal Units
800+	800-999	Animal Units
1000+	1000-1099	Animal Units
1100+, 1200+	....	Animal Units On Larger Farms

AVERAGE ANNUAL SOIL LOSS (tons/acre/year)

0-3 tons	8-10 tons
4-5 tons	11-25 tons
6-7 tons	26+ tons
	Gully

ANIMAL UNITS, POULTRY FARMS

P10	10-24	Animal Units
P25	25-49	Animal Units
P50	50-99	Animal Units
P100	100-199	Animal Units
P200	200-399	Animal Units
P400	400-599	Animal Units
P600	600-799	Animal Units
P800	800-999	Animal Units
P1000	1000-1099	Animal Units
P1100, P1200	....	Animal Units On Larger Farms

( ) Number Of Acres Available For Waste Disposal

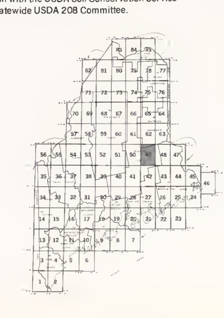
△ APPROVED ANIMAL WASTE FACILITY

ACRES

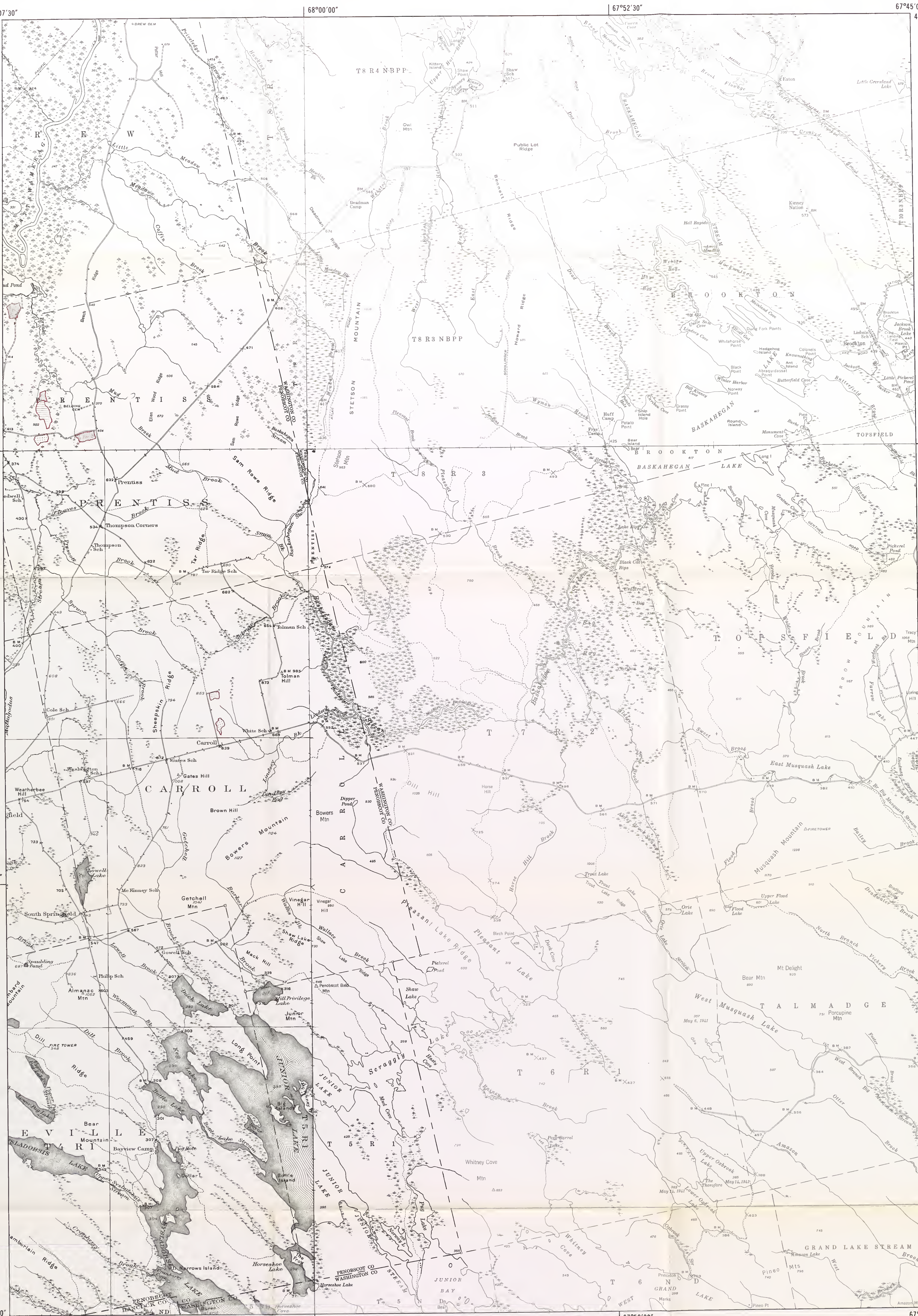
0 1 2 3 MILES

Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT



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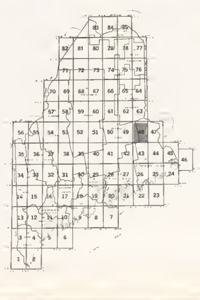
ACRES

0 1 2 3 MILES

Scale 1:50 000

N



PENOBSCOT COUNTY
SOIL AND WATER CONSERVATION DISTRICT